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Selected nutritional and biochemical characteristics of non-institutionalized rural elderly women living in Story City, Iowa

Sylvia Ruth Witte
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Selected nutritional and biochemical characteristics of non-institutionalized rural elderly women living in Story City, Iowa

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Iowa State University, 1988

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Selected nutritional and biochemical characteristics of non-institutionalized rural elderly women living in Story City, Iowa

by

Sylvia Ruth Witte

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Iowa State University

Ames, Iowa

1988

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DEDICATION

Dedicated in loving memory to my grandmother,

Margaret Pier Witte Dressesr

Grow old along with me!

The best is yet to be,

The last of life, for which the first was made:

.Our times are in his hand[1]...

---

[1]From the poem Rabbi Ben Exra written by Robert Browning, 1864.

INTRODUCTION

Life expectancy has increased due to advances in health care and nutrition. Life expectancy in the United States at the turn of the century was 48 years. In 1982, persons reaching the age of 65 had an average life expectancy of an additional 16.8 years: 14.4 years for men and 18.8 years for women (1).

Interest in gerontology has intensified because of the increased number of persons 65 years of age and older. In 1900, 4.1% of the U.S. population was 65 years of age. According to 1980 census figures, 12% of the population is 65 years of age or older. By the year 2000 the proportion of elderly will increase to 13%, and by the year 2030, approximately 21% of the population will be 65 years of age or older (1,2).

Currently, the fastest growing segment of the population is the "old-old" elderly, or those persons aged 85 years and older. In 1985, 1% of the population was at least 85 years old. By the year 2000 the "old-old" elderly will increase to about 2% of the population, and by the year 2050, 5.2% of the population will be 85 years of age or older (3).

Women live longer than men and the sex ratio of women to men increases with age. In the 65 to 69 year old age group, there are 124 women for every 100 men (ratio 1.24) and in the

85 years and older age group, there are 241 women for every 100 men (ratio 2.41) (1,3).

The state of Iowa has a sizable elderly population. According to the 1980 census, 12% of the population is 65 to 84 years old ("young-old") and nearly 2% of the population is 85 years or older. Compared with other states in the nation, Iowa ranks fourth in having the largest percentage of elderly people (1,4). Because Iowa has such a large elderly population and because limited research information is available on the "old-old" elderly and on females, it is important to examine factors that affect the nutritional health of the aging population.

Nutritional Health of Elderly Person

Nutritional health is influenced by many factors including age, sex, dietary intake, physical health, drug usage and other health-related practices. Nutritional health can be evaluated through the use of dietary intake records, anthropometric measurements, clinical examination and by the use of biochemical markers (5).

Dietary Assessment

Food records, 24-hour dietary recalls and diet histories have been used to collect dietary data. Each method has its advantages and disadvantages.

According to HANES II (Health and Nutrition Examination Survey II), dietary intakes of non-institutionalized elderly persons were satisfactory (6). Intakes of protein, iron, vitamin A, ascorbic acid, thiamin, riboflavin, and niacin met or exceeded the Recommended Dietary Allowances (RDAs). Elderly men, however, consumed 87% of the RDA for calcium, while elderly women consumed 66% of the calcium allowance.

Todhunter (7), on the other hand, found that many older men and women had nutrient intakes of less than two-thirds the RDA, and that nutrient intakes varied according to the age, race, sex, educational level and income of the individual. Based on a 24-hour dietary recall, dietary intakes of vitamin A, thiamin, riboflavin and iron were low in the 529 non-institutionalized persons, aged 60 to 102 years, who were interviewed.

Despite the fact that many elderly do seem to consume a fairly well-balanced diet, physiological changes that occur during aging may affect the nutrient needs of the elderly. Little research has been done on the impact that these age-related changes have on the nutritional status of the elderly.

Body composition, for example, is altered with age (8). As a person ages, the percent of lean body mass decreases as the amount of fat increases, and there is a shift in the distribution of total body fat. This change in body composi-

tion, in turn, alters or decreases the resting metabolic rate (RMR). Because of the decline in RMR, total energy needs are reduced. Energy needs also decrease due to the decline in physical activity that occurs as one ages (9). Because of visual changes, loss of dentition, impaired taste acuity and/or limited physical mobility, elderly persons' ability to obtain or consume a well-balanced diet may be compromised (8).

It has been suggested that the RDAs are inappropriate for elderly persons and that they need to be re-evaluated for the older population (10-13). First of all, the population of older adults is not homogeneous and diversity increases with age. Except for energy, the current RDAs have two age categories for the adult population: 1) 23 to 50 years old, and 2) 51 years and older (14). Clearly, the second age category is too broad and the RDAs are based on very limited information.

The RDAs are intended to be used for healthy populations (14). Within the elderly population, there is a high prevalence of chronic disease (1). Disease states may increase the nutrient needs of elderly persons. Under these circumstances, the RDAs should be used with caution when evaluating dietary intakes of the elderly population.

Anthropometric Measurements

Anthropometry, or the measurement of body size, weight and proportions, is a useful way to evaluate nutritional health in the elderly (5). Height, weight and skinfold thickness measurements are commonly used.

Cross-sectional and longitudinal studies have shown that height decreases with age (5,15,16). Data from HANES I showed that males, aged 65 to 74 years, were 6.1 cm shorter than their younger counter-parts 18 to 24 years old. Elderly women were found to be 5.0 cm shorter than younger females (17). In a longitudinal study, Garcia and co-workers (15) demonstrated that there was a significant decline in stature after age 45 in women. Accurate heights are difficult to obtain in some older individuals, especially if they are confined to a bed or wheelchair. Arm length and knee height measurements (18,19) have been recommended as viable alternatives for measuring stature in older persons.

In addition to height, weight is also affected by the aging process (5,15,16). Longitudinal data has indicated that weight declines in women after about 50 years of age (15). It has been suggested that the age-specific Gerontology Research Center Recommendations may be a better way to evaluate height and weight in older individuals compared with the non-age adjusted Metropolitan Life

Insurance Weight for Height Tables (20).

Skinfold measurements may be used to estimate body fat in the elderly. Most skinfold measurements tend to decrease with age (5,21). Due to age-related and disease-related physiological changes, it may be difficult to obtain and evaluate skinfold thickness and other anthropometric measurements.

Clinical Evaluation

Clinical evaluation is probably one of the oldest and simplest, yet most frequently neglected methods of evaluating nutritional health. Most people who have a nutritional deficiency do not exhibit clinically detectable symptoms of the deficiency, and some symptoms are non-specific (5). According to a study by Lowenstein (22), clinical signs of nutritional deficiencies vary with the age of the individual. In elderly persons with ascorbic acid deficiency, ecchymosis was present but none of the edentulous individuals had bleeding gums. Children, on the other hand, were more likely to have painful and swollen joints due to hemorrhages under the periosteum.

Biochemical Evaluation

Dietary, anthropometric and/or clinical assessment are combined with biochemical evaluation to appraise nutritional

health. Like the other nutritional assessment tools, biochemical markers that are used as indices of nutritional status are affected by age. Because of this age effect, interpretation becomes difficult. All serum and urine data must be interpreted with the understanding that renal function declines with age, and that there is an increased tendency for elderly persons to be over- or underhydrated (16).

Serum albumin, for example, is one of the most frequently used indices of nutritional status; however, it can be altered by many factors such as disease, infection and age. Some studies have reported that serum albumin declines with age (23).

Health Status of the Older Population

Many older persons are relatively healthy, however, there is an increased prevalence of chronic disease in this segment of the population. Most older people have at least one chronic condition and many have multiple conditions (1). The most frequently occurring conditions for the non-institutionalized elderly are: arthritis (48%), hypertension (39%), hearing impairments (29%), heart disease (30%), orthopedic impairments and sinusitis (17% each), cataracts (14%), diabetes and visual impairments (10% each) and tinnitus (9%). Despite the high prevalence of chronic disease, most elderly persons consider themselves to be

relatively healthy.

Age and Immune Function

Age-related changes in the immune system may be responsible, in part, for the increased prevalence of chronic disease and infection that is observed in the older population (24,25). Immunity is the bodies' ability to protect itself from harmful substances such as viruses, microorganisms and malignant cells. The immune system recognizes foreign substances (antigens) and destroys them so that health is maintained (26).

There are two types of immunity: cell-mediated and humoral immunity. Cell-mediated immunity is provided by T- or thymus-derived lymphocytes. T-lymphocytes are synthesized in the bone marrow and they mature in the thymus gland. Delayed cutaneous hypersensitivity, rejection of foreign grafts and the destruction of virus infected or cancer cells are all examples of cell-mediated immunity. The "skin test", or delayed cutaneous hypersensitivity, is one way to measure cell-mediated immunity (26-28).

Humoral immunity, on the other hand, is conferred by B-lymphocytes. In birds, B-lymphocytes are synthesized by the bursa of Fabricius. Man, however, has no equivalent structure and it is believed that B-lymphocytes are produced by some portion of gut-associated lymph tissue or bone

marrow. The role of the thymus gland in B-cell development is not clear; however, thymocytes are needed for the maturation and differentiation of B-lymphocytes (26-28).

When B-lymphocytes are stimulated by antigens, such as microorganisms, the by-products of T-lymphocytes and/or macrophages, they produce glycoproteins known as antibodies or immunoglobulins (Ig). Immunoglobulins are composed of four polypeptide chains (two heavy and two light chains) joined by disulfide bonds. Immunoglobulins are specific and they have antigenic memory. There are five classes of immunoglobulins-IgG, IgA, IgM, IgD and IgE. Each of the five classes has a different pair of heavy chains (gamma, alpha, mu, delta or epsilon) and a pair of either kappa or lambda light chains. Humoral immunity can be assessed by determining the concentration of one or more serum immunoglobulins (27).

As one ages, changes occur in the immune system which lead to a decline in immune function known as immunosenescence. The thymus gland involutes shortly after sexual maturity is attained, and by the fifth decade of life the thymus gland may lose up to 95% of its original mass (29). Along with the decline in thymic mass, there is a decrease in the concentration of thymic hormones (thymosin and thymopoietin) in the serum (30).

Both cellular and humoral immunity are altered with age.

Although the number of T-lymphocytes may not decrease with age, the T-cells produced are immature and functionally impaired (31,32). The inability of the T-lymphocytes to differentiate may be due to the decline in the concentration of thymic hormones in the blood.

Humoral immunity, supplied by B-lymphocytes, also declines to some extent. Changes in B-cell function may be secondary to changes in T-cell function since T-lymphocytes regulate antibody secreting B-cells (27). Some investigators have found that serum immunoglobulin concentrations are altered by age (23,33-36), while other researchers have not found age effects (37,38).

Protein-energy malnutrition (PEM) has been shown to affect immune function. Persons who are most susceptible to PEM are children in developing countries, hospitalized patients and the elderly. In PEM, the thymus gland and peripheral tissues of the immune system atrophy which causes anergy and compromises the immune response. Since PEM consists of multiple deficiencies of protein, energy, vitamins and minerals, interpretation becomes difficult (39-41).

In summary, there is an increased prevalence of chronic disease and infection in the older population which may be caused by age-related changes in the immune system. In addition to age, nutritional factors have an impact on immune

function. Age-related factors, nutritional factors and/or the interaction of both age and nutritional factors on the immune system may be responsible for the high prevalence of chronic disease and infection seen in the older segment of the population.

Blood Lipid Profiles in Elderly Persons

Longitudinal and cross sectional studies have shown that blood lipid profiles are altered with age (42,43). Data from the Framingham Study (44) indicated that serum cholesterol levels increased gradually in both males and females. After age 65, the concentration of serum cholesterol decreased slightly in males while it continued to increase in women. In advanced age, women tended to have higher mean cholesterol levels than men.

Tissue cholesterol concentrations also increased with age (45). Although the mechanism is not clearly understood, there appears to be a loss of tissue responsiveness to certain hormones which leads to an increase in cholesterol turnover and an accumulation of lipid in the tissues and serum.

Despite the fact that blood cholesterol levels increase with age, mean blood cholesterol levels in the U.S. have fallen significantly in the last 25 years (46). This decline has been attributed to several factors including diet, drugs

and exercise.

Changes in low density lipoprotein cholesterol (LDL-C) also occur with age. Based on data from The Framingham Study (44), LDL-C levels increased in males and females in their 60s and declined when the participants were in their 70s. Compared with men 60 to 70 years of age, elderly women had mean LDL-C levels that were 10 to 17 mg/dL higher. Both the number of LDL receptors in the liver and the fractional catabolic rate of LDL-C decreased with age (47). These changes may be responsible for the age-related increase in LDL-C.

Compared with total and LDL-C levels, high density lipo-protein cholesterol (HDL-C) tended to change less dramatically with age. In the Framingham Study (44), blood HDL-C levels in men remained fairly stable throughout life. In women, HDL-C increased gradually until approximately 70 years of age and then tended to decline. At all ages, the levels of HDL-C are about 10 mg/dL higher in women compared with men (48). Older women who take synthetic estrogens experience a greater increase in HDL-C compared with women who do not take hormones (49). The change in HDL-C with age may reflect an age-related decline in hepatic triglyceride lipase or a decline in the hepatic catabolism of HDL-C (50).

Data from The Framingham Study (44) indicated that levels of serum triglyceride in men appeared to decline

slightly after 50 years of age. Up until 60 to 69 years of age, women have lower serum triglyceride levels compared with men. At 70 years and beyond, women have higher serum triglyceride levels than men. The increase in blood triglyceride concentration with age is due, in part, to an age-related increase in the endogenous synthesis of hepatic triglyceride (51). Because insulin resistance, elevated plasma insulin levels, and increased adiposity often occur with age, these factors may also be responsible for the increase in blood triglyceride concentrations (52).

Although many researchers have shown that lipid profiles are affected by age, other investigators have not found an age affect on blood lipid concentrations. In a cross-sectional study by Alvarez and co-workers (53), mean values for total plasma cholesterol, HDL-C and plasma triglyceride showed no age-related differences. Mean concentrations of LDL-C, however, were significantly smaller for women who were greater than 80 years of age compared with women who were less than 80 years. Klorfajn and associates (54) found no age affects on serum cholesterol and triglyceride levels in a group of 384 males and females, aged 50 years and older.

In addition to age, drug therapy can alter blood lipid profiles. Estrogens tend to increase HDL-C and blood triglyceride concentrations in women taking synthetic hormones (49). Antihypertensive agents can also alter lipid profiles.

Thiazide diuretics tend to increase LDL-C and serum triglyceride concentrations, while beta adrenergic blocking agents tend to decrease HDL-C and increase blood triglyceride levels (55,56).

Drug Usage in Elderly Persons

Because of the high prevalence of chronic disease in the elderly population, older people are major consumers of prescription and non-prescription, i.e. over-the-counter (OTC), medications. Although the elderly constitute only 12% of the U.S. population, they purchase about 25% of the 1.5 billion prescriptions written annually (57). The average older person receives more than twice as many prescriptions than persons less than 65 years of age (57). It has been estimated that 75% of all older persons use OTC drugs and one-third of all drug expenditures by the elderly are spent on non-prescription drugs (58).

The percentage of the adult population using medications increases with age and it is highest in those persons who are 65 years of age or older. Drug usage also differs according to sex and residence. Elderly females take more prescription and non-prescription medications than males, and institutionalized older adults take more drugs than the non-institutionalized. Institutionalized elderly, for example, take an average of four to seven different drugs while the

non-institutionalized take two to four medications at a given time (58).

The most commonly used prescription drugs in the adult population are cardiovascular drugs, diuretics and analgesics. Cardiovascular drugs account for 25% of the 100 most frequently used prescription drugs, diuretics account for 15% and analgesics account for 13%. The most commonly used non-prescription drugs used by elderly persons are analgesics, antacids, laxatives and vitamins (59,60).

The physiological changes that occur with age can affect drug absorption, distribution, metabolism and excretion. Due to an age-related decline in renal function, excretion of certain drugs (digoxin) is reduced (61). Because of impaired drug excretion, drugs accumulate in the blood and there is an increased potential for adverse reactions. In addition to age, disease processes can also affect drug absorption, distribution, metabolism and excretion.

Because elderly persons often take more than one drug, or polypharmacy, there is an increased potential for drug-drug interactions. Drug-drug interactions are complex because there are thousands of different prescription and non-prescription drugs available that can be taken in a multitude of different combinations. Due to individual differences, the same combination of medications that

produces a life threatening interaction in one person may have little or no effect on another person (58,59). Antacids, for example, can increase or decrease the absorption and elimination of other drugs (62). Alcohol can interfere with a variety of prescription and non-prescription drugs to produce a wide range of adverse or lethal effects (63).

In addition to drug-drug interactions, drug-nutrient interactions may also be prevalent in older persons because of chronic drug usage. Laxatives, for example, can impair the absorption of nutrients and they can disturb water and electrolyte balance (64). Because the potential for drug-drug and drug-nutrient interactions is so great, the type and amount of drugs taken by elderly individuals should be monitored closely.

Purpose of the Study

Since the state of Iowa has a sizable elderly population and because limited research information is available on the "old-old" and elderly females, the purpose of this study was to examine selected factors that affect the nutritional health of non-institutionalized rural elderly women.

Explanation of Dissertation Format

This dissertation is composed of two papers. The first paper addresses the effects of age, diet and drug usage on serum lipid profiles of rural elderly women. In the second paper, the effects of age, diet and drug use on immune function of rural elderly women are presented. All work was done under the direction of Dr. Pilar A. Garcia.

PART 1. AGE, DRUG USE AND DIETARY EFFECTS ON SERUM LIPID PROFILES OF RURAL ELDERLY WOMEN

Age, Drug Use and Dietary Effects on Serum Lipid Profiles of Rural Elderly Women

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Supported by the Iowa Agriculture and Home Economics Experiment Station, Project 2785.

ABSTRACT

Serum lipid profiles were investigated in 65 non-institutionalized elderly females living in Story City, Iowa, a rural community. All women were mentally and physically able to participate in the study. They were not taking any drugs nor did they have any overt disease that would interfere with lipid metabolism. Data collected by personal interview included medical history, drug usage, dietary information, height and weight from 25 reference women (50-64 yrs), 28 "young-old" (65-84 yrs) and 12 "old-old" women (85-92 yrs). Fasting blood samples were obtained and analyzed for total serum cholesterol, HDL cholesterol and serum triglyceride; LDL cholesterol was calculated. Based on one 24-hour dietary recall, mean percent of kilocalories from fat was 29, P:S ratio was 0.51 and mean dietary cholesterol intake was 193 mg. Serum lipids were not affected significantly by age, drug use or age by drug use interaction. For the 65 women aged 50 to 92 years, mean concentrations of total serum cholesterol, HDL cholesterol, LDL cholesterol and serum triglyceride were 7.03 mmol/L 272 mg/dL), 1.29 mmol/L (50 mg/dL), 5.07 mmol/L (196 mg/dL) and 1.51 mmol/L (134 mg/dL), respectively. Total serum cholesterol correlated with LDL cholesterol and serum triglyceride but not with HDL cholesterol. Serum lipids and dietary lipids were not correlated.

INTRODUCTION

Life expectancy in the United States has increased and the number of elderly persons is growing rapidly. According to 1980 census figures, 12% of the population is 65 years or older. By the year 2000, the percent of elderly persons will increase to 13%; by the year 2030, 21% of the population will be 65 years of age or older (1). Currently the "old-old", or those persons 85 years or older, is the fastest growing segment of the population (2).

Approximately 15% of Iowa's population is 65 years or older and it has a large rural elderly population (1,3). Because limited research information is available on the "old-old" elderly and on women, a study was designed to examine factors that affect the nutritional health of aging elderly women in a rural Iowa community. This paper focuses on the effects of age, drug use and diet on serum lipid profiles of non-institutionalized elderly women.

METHODS

Story City, Iowa was chosen as the research site because of its large stable rural elderly population. According to the 1980 census (3), 25% of the population in Story City is 65 years of age or older. About two-thirds of the elderly people in Story City are women.

Story City is an ideal research site because of its close proximity to Iowa State University in Ames, Iowa. Like other small towns in Iowa, Story City is a "close-knit" community and it has a high proportion of residents who are of Norwegian descent[1].

Selection of Participants

Because the majority of older people is female, non-institutionalized elderly female residents of Story City were selected for the study. Females, 50 years of age and older, were recruited to represent three different age groups: reference women (50 to 64 years), "young-old" women (65 to 84 years) and "old-old" women (85 years and older).

The criteria established for the selection of participants specified that all volunteers a) be mentally

---

[1]We would like to thank Meg Speer, M.S., R.D., who was the key liaison for this study. Meg is employed as a consulting dietitian at Bethany Manor Nursing Home and at Story City Memorial Hospital in Story City.

alert, sufficiently articulate and physically able to participate in the research study b) be post-menopausal and free from any overt or occult disease that would interfere with the study (diabetes, hyperlipidemia or thyroid disorders) and c) take no medications that would interfere with the study (glucose or lipid-lowering drugs, hormones or certain antihypertensive agents). Those persons who participated in the baseline study[2] and who met the established criteria were contacted. Volunteers were recruited during January and February of 1987 and data were collected during March and April of 1987.

All participants were informed verbally and in writing about the purpose, procedure and risks of the study. The participants read and signed an informed consent form (Appendix A). The study was approved by Iowa State University Committee on the Use of Human Subjects in Research (Appendix B).

---

[2]A baseline survey was conducted by the primary author during the fall of 1985 and spring of 1986 to determine the demographic, nutritional and health-related characteristics of institutionalized and non-institutionalized rural elderly male and female residents of Story City, Iowa (unpublished data). All personal interviews were done by the primary author.

Data and Sample Collection

Data including medical history, drug usage, dietary information, height and weight history were collected by personal interview and recorded on a survey form (Appendix C). A 24-hour dietary recall was obtained from each participant. All food items were converted from household units to gram weight, coded and analyzed using the Nutreval computer program for dietary analysis[3]. All nutrient data were rounded to the nearest whole number.

Anthropometry

Body weight, without shoes and in light indoor clothing was obtained using a beam balance scale (Detecto Scales, Rogan Scale Service, Bettendorf, IA). Weight was recorded to the nearest 0.25 pound and converted to the nearest whole kilogram. Stature was measured, without shoes, to the nearest 0.01 cm according to a modified procedure described by the National Research Council on Nutritional Anthropometry (4).

---

[3]The computer program for dietary analysis, Nutreval, was developed by Robert E. Serfass, Ph.D., Department of Food and Nutrition, Iowa State University, Ames, IA. The data base for the program is the revised version of USDA Handbook No. 8, including section 13 (The USDA Nutrient Data Base for Standard Reference, (Release 5), for Microcomputers (Accession Number PB86-167525/HBF) is available from the National Technical Information Service, Springfield, VA).

Drug Usage

The participants were categorized according to medication usage. Non-drug users were those persons who used no drugs or who used prescription and/or non-prescription drugs occasionally. Drug users, on the other hand, used prescription and/or non-prescription drugs daily, excluding vitamins, minerals or eye drops.

Blood Samples

Fasting blood samples were obtained from each participant. Blood samples were collected by venipuncture by the laboratory technicians at Story City Hospital. Two 13.5 ml tubes containing no anticoagulant (Venoject Sep Vacuum Blood Collection Tube, Termo Medical Corporation, Elkton, MD) were used to obtain blood from each participant. The blood samples were centrifuged, placed on ice and transported to the Department of Food and Nutrition at Iowa State University. Aliquots of serum were placed in test tubes, labeled and stored in the ultra-cold freezer at -70° C. Serum samples for the analysis of high density lipoprotein cholesterol (HDL-C) were treated with HDL precipitating reagent (Sigma Diagnostics, St. Louis, MO), centrifuged and stored in the ultra-cold freezer.

Lipid Analysis

Serum lipids were determined by using a quantitative enzymatic reagent kit from Sigma Diagnostics. The procedures can be found in Appendix E. Serum was used for the determination of total serum cholesterol, and serum treated with a precipitating reagent (Sigma Diagnostics) was used for the analysis of HDL-C. Standard curves were made from the cholesterol calibrators (Sigma Diagnostics) for total serum cholesterol and HDL-C. The serum triglyceride standard curve was made from the triglyceride calibrators (Sigma Diagnostics). All samples were analyzed in duplicate.

Serum lipid concentrations (mg/dL) were calculated from the optical density using two different methods. The first method was based on an equation from Sigma Diagnostics (Appendix F). In the second method, lipid concentrations were determined by using the standard curve and linear regression. Lipid concentrations calculated by the two methods were closely correlated. Mean total serum cholesterol values were 263 mg/dL and 272 mg/dL ($r=0.999$, $p<0.001$), HDL-C values were 56 mg/dL and 50 mg/dL ($r=0.999$, $p<0.001$), and the serum triglyceride values were 143 mg/dL and 134 mg/dL mg/dL ($r=0.989$, $p<0.001$), for methods one and two, respectively. The serum lipid concentrations calculated from the standard curve were used since they were based on

more data. Low density lipoprotein cholesterol (LDL-C) was calculated from the equation provided in Appendix F.

Statistical Analysis

The Statistical Analysis System (SAS Institute, Inc., Cary, N.C.) was used to analyze the data (5,6). Analysis of variance, Tukey's studentized range test, Chi-square and Pearson's correlation coefficient were used. The statistical probability of $p<0.05$ was considered to be significant.

RESULTS

General Characteristics of the Participants

Twenty-five reference women (50 to 64 years), 28 "young-old" (65 to 84 years) and 12 "old-old" women (85 to 92 years) participated in the study (Table 1). The mean ages of the three groups were 57 years, 72 years and 88 years, respectively. All participants were Caucasian. Approximately 57% of the participants were of Norwegian descent.

As compared with the other two age groups, the "old-old" participants reported more chronic disease. Ninety-two percent of the reference group and 100% of the "young-old" women reported good or excellent health while 50% of the "old-old" women claimed good health. Four (33%) of the "old-old" women stated that their health was fair, one (8%) rated her health as poor and one participant (8%) did not respond to the question. According to the weight for height tables from the Gerontological Research Center (Appendix G), approximately 46% of all participants were average weight, 45% were underweight, 8% were overweight and 2% were obese.

Dietary Energy and Lipids

Mean intakes of energy, total fat, saturated fatty acids, linoleic acid and cholesterol were similar for the three age groups. Mean percent of kilocalories from fat was

29%, 11% of total kilocalories came from saturated fatty acids and 5% came from linoleic acid. The average intake of cholesterol was 193 mg and the mean P:S ratio for all participants was 0.51 (Table 2).

Mean intakes of nutrients met or exceeded the Recommended Dietary Allowances (RDAs) (7) except for folate and zinc (Appendix D). Participants consumed 33% of the RDA for zinc and 50% of the RDA for folate. Because the nutrient analysis was based on one 24-hour dietary recall and because the nutrient data bank that was used for dietary analysis had missing data for the folate and zinc content of some foods, these results must be interpreted with caution.

Drug Usage

Except for the "old-old" women, the number of drug and non-drug users in the three age groups was fairly even (Table 3). Fifty-two percent of the reference women, 57% of the "young-old" and 17% of the "old-old" women were non-drug users. Forty-eight percent of the reference women, 43% of the "young-old" and 83% of the "old-old" women were drug users. The most common types of drugs used by all participants were analgesics and antipyretics (29% of all drugs used), vitamins (18%), and minerals (11%) (Table 4).

For all participants, the total number of drugs used ranged from zero to ten. The "old-old" women used

significantly more drugs per person as compared with the "young-old" ($p<0.01$) and with the reference women ($p<0.05$). The number of drugs used by the reference and the "young-old" women were similar. The "old-old" women took an average of five different medications while the "young-old" and the reference women took an average of three drugs each (Table 5).

The number of prescription drugs used was significantly influenced by age ($p<0.05$), whereas the number of non-prescription medications was unrelated to age. The "old-old" women took significantly more prescription drugs ($p<0.05$) than either the "young-old" or the reference women. The number of prescription drugs used by the reference women was not significantly different from the number of drugs used by the "young-old" women. "Old-old" women took an average of two prescription drugs while the reference and the "young-old" women took a mean of one prescription drug each (Table 5).

Serum Lipids

Total serum cholesterol, HDL-C, LDL-C, and serum triglyceride were not significantly affected by age, drug use or age by drug use interaction. Mean values for all serum lipids are listed on Tables 6a, 6b, 6c and 6d.

Total serum cholesterol was highly correlated with LDL-C

(r=0.96, p<0.01) and with serum triglyceride (r=0.39, p<0.01). No significant correlation was found between total serum cholesterol and HDL-C (Table 7). Serum triglyceride was significantly correlated with LDL-C (r=0.33, p<0.01) and there was a significant inverse correlation between serum triglyceride and HDL-C (r= -0.61, p<0.01) (Table 7).

Serum lipids were not significantly correlated with dietary lipid intake. Serum triglyceride, however, was significantly correlated with energy (r=0.28, p<0.05) and with carbohydrate intake (r=0.29, p<0.05). There was a significant inverse relationship between LDL-C and riboflavin intake (r= -0.25, p<0.05) (Table 8).

DISCUSSION

Several research studies have reported blood lipid profiles in elderly free-living men and women (8-14). Only data for elderly women will be considered in this discussion as shown in Table 9. These research studies did not include information on medication usage and its impact on lipid metabolism.

Total serum cholesterol, LDL-C, HDL-C and serum triglyceride concentrations were not significantly affected by age, drug use or age by drug use interaction in our study. For all 65 participants, mean concentrations of total serum cholesterol, LDL-C, HDL-C and serum triglyceride were 7.03 mmol/L (272 mg/dL), 5.07 mmol/L (196 mg/dL), 1.29 mmol/L (50 mg/dL) and 1.51 mmol/L (134 mg/dL) respectively.

According to the guidelines published by the National Heart, Lung and Blood Institute and the National Institutes of Health Office of Medical Applications of Research Consensus Development Conference on Lowering Blood Cholesterol to Prevent Heart Disease (15), persons 40 years and older who have blood cholesterol levels of 260 or greater are at high risk for developing coronary heart disease. Because the mean total serum cholesterol for the women in our study was 272 mg/dL, many of the participants would be considered to be at high risk for developing heart disease. It has been

suggested, however, that the ratio of total blood cholesterol to HDL-C is a better predictor of coronary heart disease in persons 50 to 90 years of age (16,17). For the participants in our study, the total serum cholesterol to HDL-C ratio is 5.44 and the age-adjusted rate for risk of coronary heart disease is 56/1000. Although the ratio of total serum cholesterol to HDL-C is higher for participants in our study compared with the values reported on Table 9, heart disease risk is substantially lower using this predictive ratio rather than total serum cholesterol.

Based on the ANOVA, r^2 values for total serum cholesterol ($r^2 = 0.10$), LDL-C ($r^2 = 0.08$), HDL-C ($r^2 = 0.03$) and serum triglyceride ($r^2 = 0.06$) indicate that factors other than age, drug use and age by drug use interaction account for at least 90 to 97 percent of the variability in serum lipid concentrations. A multitude of factors, both biological and environmental, has an impact on the health of surviving elderly cohorts.

The mean total serum cholesterol and LDL-C concentrations for the women in our study were higher than the values reported for elderly women by other investigators (Table 9). The mean HDL-C levels in our study were similar to the values found by Alvarez and co-workers (10) but they were lower than the values in the other studies. Mean serum triglyceride levels of participants in our study were higher than the

corresponding mean values reported by several other investigators (Table 9).

The absence of age effects on total blood cholesterol in our study agrees with the reports by Alvarez and co-workers (10) and Klorfajn and associates (9). Data from the Framingham Study (8), however, showed an increasing age trend in mean serum cholesterol levels up to age 70 years followed by a decline in later years (Table 9).

Mean LDL-C was not significantly related to age in our study. Alvarez and associates (10), however, reported that mean concentrations of plasma LDL-C were significantly smaller for women who were greater than 80 years of age (114 mg/dL) as compared with women who were less than 80 years of age (135 mg/dL).

In our study, mean concentrations of HDL-C were not significantly affected by age. Alvarez and associates (10) found no age effect on plasma HDL-C. In the Framingham Study (8), mean HDL-C declined slightly in advanced age.

Age had no significant effects on serum triglyceride concentrations for the women in our study. Some investigators (9) have observed similar trends while others reported age increments in serum triglyceride levels (8).

Research studies indicate that total blood cholesterol correlates directly with the risk of coronary heart disease and HDL-C is inversely related to the risk of heart disease

(18). In our study, mean total serum cholesterol was elevated and mean HDL-C levels were within normal limits (19). Total serum cholesterol and HDL-C concentrations were not correlated.

Total serum cholesterol was significantly corrrelated with LDL-C in our study. LDL transports cholesterol to the peripheral tissues (20). Because LDL-C is the major source of total serum cholesterol, the significant correlation betweem total serum cholesterol and LDL-C was not unexpected.

Serum triglyceride was significantly correlated with total serum cholesterol and LDL-C. Although mean total serum cholesterol and LDL-C were elevated, mean serum triglyceride levels were normal (19). Elevated serum triglyceride alone is not a risk factor for coronary heart disease (21).

Total serum cholesterol, LDL-C, HDL-C and serum triglyceride were not significantly related to dietary lipid intake. Serum triglyceride, however, was significantly related to energy and carbohydrate intakes. Research studies have shown that normal men develop hypertriglyceridemia on high carbohydrate diets although the effects are small and transcient. Persons with hypertriglyceridemia, however, develop elevated blood triglyceride levels on normal diets, and blood triglyceride levels become exaggerated as dietary carbohydrate levels increase (22,23).

In our study, serum lipid concentrations were not

correlated with some of the known risk factors for heart disease. Serum lipids were not significantly related to a family history of heart disease, to exercise habits, or to the consumption of alcoholic beverages.

IMPLICATIONS

In our study, serum lipid concentrations were not significantly affected by age, drug use or age by drug use interaction in women who were greater than 50 years of age. Other investigators have demonstrated that serum lipid concentrations are affected by age and that blood cholesterol alone may not be a good predictor of heart disease risk in older people (8,16). Based on the guidelines established by the National Heart, Lung and Blood Institute and the National Institutes of Health Office of Medical Applications of Research Consensus Development Conference on Lowering Blood Cholesterol to Prevent Heart Disease (15), elderly women in this study would be considered to be at high risk for coronary heart disease. If heart disease risk is predicted by using the ratio of total blood cholesterol to HDL-C, the risk of heart disease in these women is substantially reduced. Lipid profiles of elderly women should be re-analyzed at periodic intervals to determine if elevated values persist.

Although total blood cholesterol concentration is a strong predictor of heart disease, other factors need to be considered. HDL-C, for example, is inversely associated with the risk of heart diseae (18). The mean HDL-C concentrations for women in this study were normal. Perhaps the normal

HDL-C values, as well as lifestyle practices, helped to offset any possible negative effects of the elevated total serum cholesterol levels in these apparently healthy elderly women.

Dietary factors also affect blood lipid profiles. Mean intakes of total dietary fat, saturated fatty acids and cholesterol met the guidelines established by the National Heart, Lung and Blood Institute and the National Institutes of Health Office of Medical Applications of Research Consensus Development Conference on Lowering Blood Cholesterol to Prevent Heart Disease (15). Because dietary intake was based on one 24-hour dietary recall, these values may not be a true reflection of the participants habitual intakes of fat, saturated fatty acids and cholesterol. Serum lipids were not significantly correlated with dietary lipid intake.

In addition to diet, other lifestyle factors need to be considered. None of the women in this study were taking any medications or had any disease conditions that would affect blood lipids. Only a few of the women drank alcoholic beverages and none of the women smoked tobacco. Many of the women exercised regularly. Regular and vigorous exercise has been shown to decrease cardiovascular risk by increasing HDL-C (24). Regular exercise helps to maintain acceptable body weight.

Because blood lipid profiles may or may not be affected

by age, blood lipid standards need to be re-evaluated for the healthy older population. The ratio of total blood cholesterol to HDL-C may be a better predictor of heart disease in the elderly population than total blood cholesterol levels (16,17). Health-related practices such as diet, drug use, and exercise habits should also be considered. Because individual differences increase with age, it is important to individualize dietary, drug and lifestyle interventions to improve the health and quality of life in the aged elderly.

Table 1. Mean age, height and weight of participants

	age groups[a]			
	reference (no.=25)	"young-old" (no.=28)	"old-old" (no.=12)	total (no.=65)
age (yrs)	57 ± 1[b]	72 ± 1	88 ± 1	69 ± 1
height (cm)[c]	161.9 ± 1.4[1]	157.2 ± 1.1*[2]	152.0 ± 2.6**[2]	158.1 ± 1.0
weight (kg)[d]	65 ± 2	65 ± 2	57 ± 3	63 ± [illegible]*
body weight history				
heaviest weight (kg)[e]	71 ± 3	69 ± 2	67 ± 3	70 ± 2
age (yrs)	46 ± 3	59 ± 3	40 ± 6	50 ± 2
lightest weight (kg)[f]	51 ± 1	54 ± 1	51 ± 2	52 ± 1
age (yrs)	29 ± 2	36 ± 4	60 ± 9	37 ± 3

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Mean ± S.E.M.

[c]Actual height measured to the nearest 0.1 cm.

[d]Actual weight measured to the nearest 0.25 pound and converted to the nearest whole kg. Based on ANOVA, actual measured weight was significantly ($p<0.05$) affected by age.

[e]Heaviest weight and age at heaviest weight as reported by the participant.

[f]Lighest weight and age at lightest weight as reported by the participant.

*Means within the same row having different numerical superscripts differ significantly ($p<0.05$) using Tukey's studentized range test. Means with the same numerical superscripts are not significantly different.

**Means within the same row having different numerical superscripts differ significantly ($p<0.01$) using Tukey's studentized range test. Means with the same numerical superscripts are not significantly different.

Table 2. Mean dietary intake of energy and selected nutrients[a]

	age groups[b]					
	reference (no.=25)			"young-old" (no.=28)		
energy (kcal)	1430	±	91[c]	1364	±	52
energy (kj)[d]	5983	±	381	5707	±	218
protein (gm)	65	±	3	72	±	3
% kcal	19	±	1	22	±	1
carbohydrate (gm)	185	±	13	180	±	9
% kcal	50	±	4	50	±	3
fat (gm)	51	±	5	42	±	3
% kcal	31	±	3	27	±	2

[a]Based on one 24-hour dietary recall. The computer program for dietary analysis (Nutreval) was developed by Robert E. Serfass, Ph.D., Department of Food and Nutrition, Iowa State University. The data base for the program is the revised version of USDA handbook No. 8 including section 13 (1986). Because the nutrient data base is missing data for some of the food items, the carbohydrate, saturated fatty acid, oleic acid, linoleic acid, cholesterol, zinc and folate analyses are incomplete.

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[c]Mean ± standard error of the mean.

[d]Kj = kcal X 4.184.

"old-old" (no.=12)			total (no.=65)		
1393	±	106	1395	±	45
5828	±	444	5837	±	188
64	±	4	68	±	2
19	±	1	20	±	1
186	±	16	183	±	7
51	±	5	50	±	2
47	±	5	47	±	2
29	±	3	29	±	1

Table 2 (continued)

	age groups	
	reference (no.=25)	"young-old" (no.=28)
saturated fatty acids (gm)	19 ± 10	15 ± 7
% kcal	12 ± 6	10 ± 5
oleic acid (gm)	18 ± 8	14 ± 6
% kcal	11 ± 5	9 ± 4
linoleic acid (gm)	8 ± 5	8 ± 4
% kcal	5 ± 3	5 ± 3
P:S ratio[e]	0.48 ± 0.06	0.58 ± 0.07
cholesterol (mg)	224 ± 125	176 ± 69

[e]P:S (polyunsaturated/saturated) ratio = linoleic acid (gm)/saturated fat (gm).

"old-old" (no.=12)	total (no.=65)
18 ± 8	17 ± 9
12 ± 5	11 ± 6
17 ± 7	16 ± 7
11 ± 5	10 ± 5
7 ± 3	8 ± 4
5 ± 2	5 ± 3
0.38 ± 0.04	0.51 ± 0.04
168 ± 48	193 ± 94

Table 3. Age groups and drug usage of participants

	drug usage[a]			
	non-drug users (no.=31)		drug users (no.=34)	
	no.	%	no.	%
age groups[b]				
reference	13	52	12	48
"young-old	16	57	12	43
"old-old"	2	17	10	83
total	31	48	34	52

[a]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. Drug users: women who use prescription and/or non-prescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 4. Prescription and non-prescription drug usage by participants

	age groups[a]			
	reference (no.=25)		"young-old" (no.=28)	
type of drug[b]	no.	%	no.	%
antihistamine	6	8	0	0
anti-infective agents	0	0	1	1
sympathomimetic agents	5	7	0	0
cardiac drugs	2	3	3	4
hypotensive agents	0	0	4	6
vasodilating agents	1	1	2	3
analgesics and antipyretics	23	32	21	29
anticonvulsants	1	1	1	1
antidepressants	1	1	0	0

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Based on the classification of the National Center for Health Statistics, H. Koch. Drugs most frequently used in office practice: National Ambulatory Medical Care Survey, 1981. Advance Data From Vital and Health Statistics, No. 89. DHHS Pub. No. (PHS)83-1250. Public Health Service, Hyattsville, Md. April, 1983.

"old-old" (no.=12)		total (no.=65)	
no.	%	no.	%
0	0	6	3
1	2	2	1
0	0	5	2
5	8	10	5
2	3	6	3
1	2	4	2
14	24	58	29
0	0	2	1
0	0	1	<1

Table 4 (continued)

	reference (no.=25)		"young-old" (no.=28)	
	no.	%	no.	%
tranquilizers, sedatives and hypnotics	0	0	0	0
diuretics	0	0	0	0
replacement solutions	1	1	1	1
miotics	0	0	2	3
antacids and adsorbents	7	10	3	4
cathartics and laxatives	1	1	4	6
emetics and anti-emetics	0	0	0	0
emollients, protectants and demulcents	0	0	0	0
vitamins	13	18	16	22
minerals	9	13	11	15
other agents	2	3	3	4
total number drugs used	72	100	72	100

"old-old" (no.=12)		total (no.=65)	
no.	%	no.	%
2	3	2	1
4	7	4	2
2	3	4	2
1	2	3	2
6	10	16	8
8	14	13	6
1	2	1	<1
1	2	1	<1
7	12	36	18
2	3	22	11
2	3	7	3
59	100	203	100

Table 5. Mean number of prescription, non-prescription and total drugs used by the participants

	age groups[a]			
	reference (no.=25)	"young-old" (no.=28)	"old-old" (no.=12)	total (no.=65)
	drugs used per person			
prescription drugs	0.7 ± 0.2*[1]	0.6 ± 0.2*[1]	1.6 ± 0.5[2]	0.8 ± 0.1
non-prescription drugs	2.2 ± 0.3	1.9 ± 0.4	3.3 ± 0.7	2.3 ± 0.3
all drugs	2.9 ± 0.4*[1]	2.6 ± 0.4**[1]	4.9 ± 0.7[2]	3.1 ± 0.3

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

*Mean ± standard error of the mean. Means within the same row having different numerical superscripts differ significantly ($p<0.05$) using Tukey's studentized range test. Means with the same numerical superscript are not significantly different.

**Mean ± standard error of the mean. Means within the same row having different numerical superscripts differ significantly ($p<0.01$) using Tukey's studentized range test. Means with the same numerical superscript are not significantly different.

Table 6a. Mean serum lipids--LDL cholesterol

	no.	LDL cholesterol[a]	
		mmol/L	(mg/dL)
age groups[b]			
reference	25	5.02 ± 0.31[c]	(194 ± 12)
"young-old"	28	5.30 ± 0.23	(205 ± 9)
"old-old"	12	4.68 ± 0.31	(181 ± 12)
total	65	5.07 ± 0.16	(196 ± 6)
drug usage[d]			
non-drug users	31	4.86 ± 0.26	(188 ± 10)
drug users	34	5.28 ± 0.21	(204 ± 8)

[a]LDL cholesterol=total cholesterol-((triglycerides/5)+ HDL cholesterol).

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[c]Mean ± standard error of the mean. Values are given in SI units (mmol/L) and in traditional units (mg/dL).

[d]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. Drug users: women who use prescription and/or non-prescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

Table 6b. Mean serum lipids--total cholesterol

	no.	total cholesterol	
		mmol/L	(mg/dL)
age groups[b]			
reference	25	6.85 ± 0.31[c]	(265 ± 12)
"young-old"	28	7.34 ± 0.26	(284 ± 10)
"old-old"	12	6.70 ± 0.39	(259 ± 15)
total	65	7.03 ± 0.18	(272 ± 7)
drug usage[d]			
non-drug users	31	6.78 ± 0.26	(262 ± 10)
drug users	34	7.27 ± 0.23	(281 ± 9)

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[c]Mean ± standard error of the mean. Values are given in SI units (mmol/L) and in traditional units (mg/dL).

[d]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. Drug users: women who use prescription and/or non-prescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

Table 6c. Mean serum lipids--HDL cholesterol

	no.	HDL cholesterol	
		mmol/L	(mg/dL)
age groups[b]			
reference	25	1.29 ± 0.05[c]	(50 ± 2)
"young-old"	28	1.29 ± 0.05	(50 ± 2)
"old-old"	12	1.32 ± 0.08	(51 ± 3)
total	65	1.29 ± 0.03	(50 ± 1)
drug usage[d]			
non-drug users	31	1.34 ± 0.05	(52 ± 2)
drug users	34	1.27 ± 0.05	(49 ± 2)

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[c]Mean ± standard error of the mean. Values are given in SI units and in traditional units (mg/dL).

[d]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. Drug users: women who use prescription and/or non-prescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

Table 6d. Mean serum lipids--triglyceride

	no.	triglyceride	
		mmol/L	(mg/dL)
age groups[b]			
reference	25	1.35 ± 0.10[c]	(120 ± 9)
"young-old"	28	1.63 ± 0.16	(144 ± 14)
"old-old"	12	1.58 ± 0.15	(140 ± 13)
total	65	1.51 ± 0.09	(134 ± 8)
drug usage[d]			
non-drug users	30	1.43 ± 0.12	(127 ± 11)
drug users	34	1.59 ± 0.12	(141 ± 11)

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[c]Mean ± standard error of the mean. Values are given in SI units (mmol/L) and in traditional units (mg/dL).

[d]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. Drug users: women who use prescription and/or non-prescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

Table 7. Correlations between serum lipids

	total cholesterol	LDL cholesterol	HDL cholesterol	triglyceride
serum lipids				
total cholesterol	1.00	0.96**	0.08	0.39**
LDL cholesterol	0.96**	1.00	<0.01	0.33**
HDL cholesterol	0.08	<0.01	1.00	-0.61**
triglyceride	0.39**	0.33**	-0.61**	1.00

*$p<0.05$ using Pearson's Correlation Coefficient.

**$p<0.01$ using Pearson's Correlation coefficient.

Table 8. Correlations between serum lipids and dietary intake

	total cholesterol	LDL cholesterol	HDL cholesterol	triglyceride
dietary intake[a]				
energy	0.20	0.14	-0.09	0.28*
carbohydrate	0.17	-0.12	-0.14	0.29*
riboflavin	-0.24	-0.25*	-0.18	0.02

[a]No statistically significantly correlations between serum lipids and protein, total fat, saturated fatty acids, oleic acid, linoleic acid, cholesterol, calcium, phosphorus, iron, sodium, potassium, vitamin A, thiamin, niacin, ascorbic acid, zinc or folate intake.

*$p<0.05$ using Pearson's Correlation Coefficient.

Table 9. Blood lipid profiles of non-institutionalized elderly women[a]

reference location	participants	age range	total cholesterol	LDL-C
	no.	yrs	mg/dL	mg/dL
Present study Iowa	25	50-64	265	194
	28	65-84	284	205
	12	85-92	259	181
Kannel (8) Framingham study Massachusetts		50-54	245	142.9
		55-59	253	156.2
		60-64	256	159.2
		65-69	258	159.6
		70-74	255	157.1
		75-79	246	156.9
Abraham et al. (13) HANES I U.S.	832	45-54	232	
	670	55-64	245	
	1811	65-74	250	
Fulwood et al. (14) HANES II U.S.	763	45-54	232	
	1329	55-64	249	
	1416	65-74	246	

[a]Serum lipid values from cited studies included both men and women but values for comparison were limited to women.

HDL-C	triglyceride	total-C / HDL-C	interpretation
mg/dL	mg/dL		
50	120	5.30	No significant effects of age, drug use or age by drug use interaction for serum lipids examined.
50	144	5.70	
51	140	5.01	
59.8	117.9	4.10	Total serum cholesterol and LDL-C increase with age then decline. HDL-C declines with age. Serum triglyceride increases with age.
58.1		4.35	
57.2	127.0	4.48	
57.2		4.51	
55.8	136.1	4.57	
53.5		4.60	
			Age effects not examined statistically.
			Age effects not examined statistically.

Table 9 (continued)

reference location	participants	age range	total cholesterol	LDL-C
	no.	yrs	mg/dL	mg/dL
Yearick (12) Oregon	75	63-96	212.6	
Nicholson et al. (11) Ohio	114	80+	219	132
Klorfajn et al. (9) Israel	15	50-59	226	
	73	60-69	238	
	48	70-79	228	
	12	80-99	222	
Alvarez et al. (10) Spain		65-95	204 (no.=86)	
		65-95		126 (no.=65)
		65-95		
		65-95		

HDL-C	triglyceride	total-C / HDL-C	interpretation
mg/dL	mg/dL		
			Age effects not examined statistically.
58	147	3.78	Age effects not examined.
	131		No age effects in serum lipids.
	112		
	100		
	124		
		4.08	LDL-C significantly affected by age.
50 (no.=82)			
	112 (no.=83)		

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PART 2. AGE, DRUG USE AND DIETARY EFFECTS ON IMMUNE FUNCTION OF RURAL ELDERLY WOMEN

Age, Drug Use and Dietary Effects on Immune Function of Rural Elderly Women

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ABSTRACT

As part of a lipid study, immune function was investigated in 65 non-institutionalized elderly women living in Story City, Iowa, a rural community. Twenty-five women were 50 to 64 years of age (reference group), 28 women were 65 to 84 years ("young-old" group) and 12 women were 85 to 92 years of age ("old-old" group). All participants were mentally and physically able to participate in the study. They had no overt disease and they were not taking any medications that would interfere with the study. Fasting blood samples were obtained and analyzed for serum immunoglobulins (IgG, IgA and IgM), serum albumin and total serum protein. Except for IgA, mean immunoglobulin concentrations were not significantly affected by age. Mean serum IgA levels were significantly lower in the reference women as compared with the "young-old" and the "old-old" women. Mean serum albumin concentrations were significantly affected by age but not by drug use. Mean total serum protein levels were significantly affected by drug use but not by age. Mean concentrations of serum immunoglobulins, serum albumin and total serum proteins were within normal limits for all participants.

INTRODUCTION

Currently the fastest growing segment of the population is the "old-old", or those persons 85 years or older. By the year 2000, 2% of the population will be at least 85 years of age, and by 2050, 5.2% of the population will be 85 years or older. Women live longer than men and the sex ratio of women to men increases with age (1).

The state of Iowa has a sizable elderly population. Approximately 15% of Iowa's population is 65 years or older (2,3). Because limited information is available on the "old-old" and on aging women, a research study was conducted to examine selected factors that affect the nutritional health of aging women.

Few studies have examined the immune function in well-elderly individuals, particularly the "old-old" people. One phase of this study explored the immune function in rural elderly non-institutionalized women and examined the influence of age, drug use and dietary intake on immune function. Studies of this nature will help determine the usefulness of immune function as an index of nutritional status in well-elderly individuals. This paper focuses on immune function in aging rural women.

METHODS

Study Participants

Non-institutionalized elderly female residents of Story City, Iowa were recruited for this study. Sixty-five women, 50 years of age and older, were selected according to specified criteria to represent three age groups[1]. The reference women were 50 to 64 years, "young-old" women were 65 to 84 years and "old-old" women were 85 years of age and older. All 65 participants were mentally and physically alert, sufficiently articulate and physically able to participate in the study. They were free from overt disease and were not taking any medications that would interfere with the study. All women were White and post-menopausal.

Data on medical history, drug usage and dietary information were obtained through a personal interview by the present investigator. Participants were categorized according to drug usage: non-drug users and drug users. Non-drug users used either no drugs or used prescription and/or non-prescription drugs occasionally. Drug users, on the other hand, used prescription and/or non-prescription drugs regularly, or daily, excluding vitamins, minerals or eye drops.

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[1]See PART 1. AGE, DRUG USE AND DIETARY EFFECTS ON SERUM LIPID PROFILES OF RURAL ELDERLY WOMEN.

All participants were informed verbally and in writing about the purpose, procedure and risks of the study. The participants read and signed an informed consent form (Appendix A). This study was approved by Iowa State University Committee on the Use of Human Subjects in Research (Appendix B).

Analysis of Immunoglobulins and Serum Proteins

A fasting blood sample was obtained by venipuncture from each participant. Blood samples were centrifuged, placed on ice and transported to the Department of Food and Nutrition at Iowa State University. Aliquots of serum were placed in test tubes, labeled and stored in the ultra-cold freezer at -70° C. Blood samples were analyzed for serum immunoglobulins (IgG, IgA and IgM), serum albumin and total serum protein.

An immunoglobulin test kit (Kallestad Laboratories, Austin, TX) was used to determine the concentration of serum immunoglobulins (IgG, IgA and IgM) by single radial diffusion. All samples were analyzed in duplicate. Control sera and three immunoglobulin reference sera (Kallestad Diagnostics) were used to develop a standard curve for each immunoglobulin. After incubating at $23 \pm 2^{\circ}$ C for 48 (IgG and IgA) or 72 hours (IgM), ring diameters were measured to the nearest 0.0001 inch using a Gaertner Toolmakers

Microscope (Gaertner Scientific Corporation, Chicago, IL). All values were converted to millimeters. Concentrations (mg/dL) of each of the immunoglobulins were calculated from the standard curves.

Serum albumin and total serum protein were determined by using an automated colorimetric method (Roto Chem IIa, American Scientific, Scientific Product Division, Baxter, Deerfield, IL). SpecTru BCG Albumin Reagent (Pierce Chemical Company, Rockford, IL) and Total Protein Reagent (Gilford System, Oberlin, OH) were used for the analyses. All samples were analyzed in duplicate[2].

Statistical Analysis

The Statistical Analysis System (SAS Institute, Inc., Cary, N.C.) was used to analyze the data (4,5). Analysis of variance (ANOVA), Bonferroni's multiple range test, and Pearson's correlation coefficient were used when appropriate. The statistical probability of $p < 0.05$ was considered to be significant.

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[2]Analyzed by Dorothy Williams, Medical Technologist, Veterinary Pathology Department, Iowa State University.

RESULTS

Data were obtained on 25 reference women (50 to 64 years), 28 "young-old" (65 to 84 years) and 12 "old-old" women (85 years of age or older). Except for the "old-old", the number of drug and non-drug users was fairly equal in each of the three age groups (Table 1).

Participants met or exceeded the Recommended Dietary Allowances (RDAs) (6) for energy and all nutrients except for folate and zinc (Appendix D). Because the nutrient analysis was based on one 24-hour dietary recall and because the nutrient data bank used for dietary analysis was missing data for the folate and zinc content of some foods, these results must be interpreted with caution.

The immunoglobulin values for one "young-old" woman were not included in the analysis because they were outside the standard curve. Therefore, the total number of subjects was 64. Based on the analysis of variance, serum IgG concentrations showed significant effects of age ($p<0.01$), drug use ($p<0.01$) and age by drug use interaction ($p<0.01$). Because there was a significant age by drug use interaction, it was not possible to isolate either a true age effect or a true drug use effect. The "old-old" non-drug users consisted of only two individuals and the sample group response may not be representative of the true effects of either age or drug use.

Mean serum IgG concentrations are listed in Table 2.

The mean serum IgA levels were significantly affected by age ($p<0.01$) but not by drug use or age by drug use interaction. Mean serum IgA concentrations in reference women were significantly lower than the levels found in "young-old" ($p<0.05$) and in "old-old" women ($p<0.05$). Mean serum IgA concentrations were similar for the "young-old" and the "old-old" women (Table 3b). Mean serum IgM concentrations showed no significant effects of age, drug use or age by drug use interaction. Mean values are given in Table 3a.

Mean serum albumin levels were not significantly affected by drug use or age by drug use interaction. Age effects, however, were significant ($p<0.01$). Serum albumin concentrations in the reference women were significantly higher ($p<0.01$) than those levels found in the "young-old" and in "old-old" women ($p<0.05$). Similar mean serum albumin concentrations were found in the "young-old" and the "old-old" women (Table 4).

Mean total serum protein concentrations were not significantly affected by age or age by drug use interaction; however, they were influenced by drug use ($p<0.05$). Non-drug users had significantly higher concentrations of mean total serum proteins (73 g/L) compared to the values obtained for drug users (71 g/L) (Table 4).

Based on the ANOVA, r^2 values for IgG, IgA and IgM were

0.23, 0.18 and 0.04 respectively. For serum albumin and total serum protein, the r^2 values were 0.23 and 0.08 respectively. Factors other than age, drug use or age by drug use interaction account for about 80 percent of the variability in serum IgG, IgA and serum albumin concentrations. For IgM and total serum protein concentrations, unidentified factors account for about 95 percent of the variability.

Serum immunoglobulin concentrations were not significantly correlated with each other (Table 5). IgG was significantly correlated with total serum protein ($r=0.84$, $p<0.01$) and there was a significant inverse correlation between serum IgA and serum albumin ($r= -0.25$, $p<0.05$, Table 5).

Serum immunoglobulins were not correlated with most of the nutrients examined (Table 6). Serum IgM correlated significantly with energy ($r=0.30$, $p<0.05$), protein ($r=0.29$, $p<0.05$), carbohydrate ($r=0.34$, $p<0.01$) and calcium intake ($r=0.30$, $p<0.05$). Serum IgG and niacin intake were inversely correlated ($r= -0.26$, $p<0.05$).

Serum albumin was significantly correlated with total fat ($r=0.30$, $p<0.05$), saturated fat ($r=0.27$, $p<0.05$), oleic acid ($r=0.28$, $p<0.05$), cholesterol ($r=0.27$, $p<0.05$) and sodium intake ($r=0.27$, $p<0.05$). Total serum protein and niacin intake correlated inversely ($r= -0.24$, $p<0.05$). Serum

proteins were not significantly correlated with energy or with any of the other nutrients (Table 7).

DISCUSSION

Few studies have explored serum immunoglobulin concentrations in elderly individuals. Some investigators have found a sex difference in mean serum immunoglobulin concentrations. Buckley and Dorsey (7) reported that mean IgA concentrations were 24% higher in white males compared with white females and mean IgM levels were 11% lower in white males compared with white females. No sex differences in mean serum IgG concentrations were observed for the 819 male and female subjects, one to 92 years, who were studied by these investigators.

Dworsky and co-workers (8), on the other hand, found no statistically significant sex differences in serum IgG, IgA or IgM concentrations in 19 male and female participants aged 83 to 104 years. Buckley and Dorsey (9) reported no sex difference in serum immunoglobulin levels in the 811 healthy individuals aged birth to 92 years.

Several investigators did not analyze serum immunoglobulin data by sex and/or they failed to examine the effects of gender on the serum immunoglobulin concentrations of the elderly persons who were studied (10-13).

Age effects on serum immunoglobulin concentrations have been found by some researchers (7,9,10,12,13), while others did not find an age effect (8,11). Because several of the

investigators who reported a significant age effect did not analyze the data for the effect of gender, it is not possible to compare our results with their data.

Although no age or sex differences in mean serum immunoglobulin concentrations were found by Norberg (11), mean serum concentrations in mg/dL were: IgG 1055, IgA 201 and IgM 76 for the 47 women aged 65 to 92 years. In our study, mean serum immunoglobulin concentrations were higher (IgG 1110 mg/dL, IgA 214 mg/dL, IgM 159 mg/dL) than the values found by Norberg. For all participants, mean serum immunoglobulin concentrations were within normal limits (14).

The mean concentration of serum albumin in the reference women (4.2 g/dL) was significantly higher than the values for the "young-old" (4.0 g/dL) and the "old-old" women (3.9 g/dL). Sherman and associates (15) reported a mean serum albumin concentration of 4.1 g/dL for 27 women aged 72 to 95 years.

No effects of age or age by drug use interaction were found in total serum protein concentrations; however, non-drug users had significantly higher mean total serum protein concentrations (73 g/L) compared with those women who used drugs (71 g/L). These trends suggest that the drugs used by these women tend to reduce total serum protein levels.

Serum immunoglobulins were not significantly correlated with each other. Serum IgG, however, correlated significant-

ly with total serum protein, and serum IgA correlated inversely with serum albumin. Total serum protein includes serum albumin and the immunoglobulins. The significant correlation between serum IgG and total serum protein concentrations may reflect the predominance of the IgG component. The significant inverse relationship between serum IgA and serum albumin, however, may be an artifact.

Nutritional status may affect immune function in elderly persons. Bodgen and associates (16) reported that mononuclear cell zinc levels and platelet zinc concentrations were significantly decreased in the 100 elderly individuals, 60 to 89 years of age, who either did not respond or who responded sub-optimally to delayed dermal hypersensitivity. These results suggest that zinc status may affect cell-mediated immunity in elderly individuals.

Goodwin and Garry (17), on the other hand, did not find a significant correlation between nutritional status and immune function in a recent study of 230 elderly males and females, 65 to 94 years. Immune function was assessed by using delayed cutaneous hypersensitivity and concentrations of specific serum constituents but not serum immunoglobulins. In this particular study, nutritional status was assessed by using three day diet records and by biochemical analysis of blood for vitamins A, B_{12}, C, D, E, riboflavin, folate, iron, copper and zinc. Serum albumin and total serum protein were

not analyzed.

Research studies have suggested a relationship between immune function and malnutrition. Immune function is impaired in persons with protein-energy malnutrition (18,19).

In our study, the mean concentrations of serum albumin and total serum protein were within acceptable limits for all the women (14). Except for folate and zinc, mean nutrient intakes met or exceeded the RDAs for all participants. Because dietary intake was based on one 24-hour dietary recall and because the nutrient data base used had incomplete information on folate and zinc, the actual amounts of folate and zinc consumed by the participants may be much greater than the amounts indicated in their records. The limited nutrient data suggests that the elderly participants had acceptable nutritional status.

The serum immunoglobulin concentrations examined in this study were not significantly correlated with most of the nutrients. Biochemical indices, however, often fail to correlate with dietary data because the "usual intake" is difficult if not impossible to determine with the currently available dietary methods.

IMPLICATIONS

Immunocompetence as a functional test of nutritional status was explored in a study of 65 well elderly women aged 52 to 92 years. Concentrations of serum immunoglobulins (IgG, IgA and IgM), albumin and total proteins were within normal limits. A significant direct correlation between serum IgG concentration (the predominant immunoglobulin) and total serum protein suggests that IgG may be used as an index of protein status. Compared to total serum protein, serum albumin is a better index of protein status. In our study, relationships between serum immunoglobulins and serum albumin were not clear-cut.

The lack of correlation between biochemical markers and dietary intake is well documented in the literature. Current dietary methodology fails to measure the "usual intake" of individuals. Several random 24-hour dietary recalls over a period of time may give a better estimate of elderly individuals usual eating pattern. Personal interviews by the the same trained individual would help improve the "recall" competency of the elderly people.

Age, drug use, and age by drug use interaction accounted for a very small portion of the variability in the biochemical indices examined in this study. Unidentified factors accounted for most of the variability in the serum immuno-

globulin, albumin and total protein concentrations of these women. A larger sample size, especially in the "old-old" group, would help clarify the trends noted in this study.

In relatively healthy elderly women such as the participants in our study, additional factors that have an impact on nutritional health and immune function need to be identified. Biochemical markers of immunocompetence for the aging population should be sensitive and specific at marginal or subclinical nutritional states. The diversity of factors that affect the nutritional health and immune function of free-living elderly individuals, contributes greatly to the difficulty in understanding the complex relationship between nutrition and immune function.

Table 1. Age groups and drug usage of participants

	drug usage[a]			
	non-drug users (no.=31)		drug users (no.=34)	
	no.	%	no.	%
age groups[b]				
reference	13	52	12	48
"young-old	16	57	12	43
"old-old"	2	17	10	83
total	31	48	34	52

[a]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. Drug users: women who use prescription and/or non-prescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 2. Mean serum IgG concentrations

	no.	IgG	
		g/L	(mg/dL)
reference[a]			
non-drug users[b]	13	10.82 ± 0.75**	(1080 ± 75)
drug users	12	9.77 ± 0.39	(977 ± 39)
"young-old"			
non-drug users	16	12.10 ± 1.48	(1210 ± 148)
drug users	12	10.98 ± 0.52	(1098 ± 52)
"old-old"			
non-drug users	2	16.33 ± 2.97	(1633 ± 297)
drug users	10	10.59 ± 0.69	(1059 ± 69)

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs. One outlier in the "young-old group, 33.16 g/L (3316 mg/dL), was not included in the analysis.

[b]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. One outlier, 33.16 g/L (3316 mg/dL), was not included in the analysis. Drug users: women who use prescription and/or nonprescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

**Mean ± standard error of the mean. Values are given in SI units (g/L) and in traditional units (mg/dL). ANOVA indicated a significant age ($p<0.01$), drug use ($p<0.01$) and age by drug use interaction ($p<0.01$).

Table 3a. Mean serum immunoglobulin concentrations-IgM

	no.	IgM	
		g/L	(mg/dL)
age groups[a]			
reference	25	1.73 ± 0.15[b]	(173 ± 15)
"young-old"	27	1.50 ± 0.13	(150 ± 13)
"old-old"	12	1.52 ± 0.19	(152 ± 19)
total	64	1.59 ± 0.09	(159 ± 9)
drug usage[c]			
non-drug users	30	1.59 ± 0.13	(159 ± 13)
drug users	34	1.59 ± 0.12	(159 ± 12)

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs. One outlier, 0.26 g/L (25 mg/dL), was not included in the analysis.

[b]Mean ± S.E.M. Values are given in SI units (g/L) and in traditional units (mg/dL).

[c]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. One outlier, 0.26 g/L (26 mg/dL), was not included in the analysis. Drug users: women who use prescription and/or nonprescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

Table 3b. Mean serum immunoglobulin concentrations-IgA

	no.	IgA	
		g/L	(mg/dL)
age groups[a]			
reference	25	1.79 ± 0.15*[1]	(179 ± 15)
"young-old"	27	2.31 ± 0.20[2]	(231 ± 20)
"old-old"	12	2.51 ± 0.25[2]	(251 ± 25)
total	64	2.14 ± 0.12	(214 ± 12)
drug usage[c]			
non-drug users	30	2.10 ± 0.15	(210 ± 15)
drug users	34	2.19 ± 0.18	(219 ± 18)

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs. One outlier in the "young-old" group, -0.26 g/L (-26 mg/dL), was not included in the analysis.

[c]Non-drug users: women who use no drugs or who use or who use pre-scription and/or non-prescription drugs occasionally. One outlier, -0.26 g/L (-26 mg/dL), was not included in the analysis. Drug users: women who use prescription and/or non-prescription drugs regularly (daily) excluding vitamins, minerals or eye drops.

*Mean ± standard error of the mean. Values are given in SI units (g/L) and in traditional units (mg/dL). Means within the same column having different numerical superscripts differ significantly ($p<0.05$) using Bonferroni's test. Means with the same numerical superscript are not significantly different.

Table 4. Mean serum albumin and total serum protein concentrations

	no.	serum albumin		total serum protein	
		g/L	(g/dL)	g/L	(g/dL)
age groups[a]					
reference	25	42 ± 1[1]	(4.2 ± 0.1)	72 ± 1	(7.2 ± 0.1)
"young-old"	28	40 ± <1**[2]	(4.0 ± <0.1)	72 ± 1	(7.2 ± 0.1)
"old-old"	12	39 ± 1*[2]	(3.9 ± 0.1)	72 ± 1	(7.2 ± 0.1)
total	65	40 ± <1	(4.0 ± <0.1)	72 ± 1	(7.2 ± 0.1)
drug usage[b]					
non-drug users	31	40 ± <1	(4.0 ± <0.1)	73 ± 1*[1]	(7.3 ± 0.1)
drug users	34	40 ± <1	(4.0 ± <0.1)	71 ± 1[2]	(7.1 ± 0.1)

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Non-drug users: women who use no drugs or who use prescription and/or non-prescription drugs occasionally. Drug users: women who use prescription or non-drugs regularly (daily) excluding vitamins, minerals or eye drops.

*Mean ± standard error of the mean. Values are given in SI units (g/L) and in traditional units (g/dL). Means within the same column having different numerical superscripts differ significantly using Bonferonni's test. Means with the same numerical superscript are not significantly different.

**Mean ± standard error of the mean. Values are given in SI units (g/L) and in traditional units (g/dL). Means within the same column having different numerical superscripts differ significantly using Bonferonni's test. Means with the same numerical superscript are not significantly different.

Table 5. Correlations between serum immunoglobulins and serum proteins

	serum IgG	serum IgA	serum IgM
serum immunoglobulins			
IgG	1.00	0.03	-0.13
IgA	0.03	1.00	0.08
IgM	-0.13	0.08	1.00
serum proteins			
albumin	-0.20	-0.25*	-0.08
total protein	0.84**	-0.01	-0.06

*$p<0.05$ using Pearson's Correlation Coefficient.

**$p<0.01$ using Pearson's Correlation Coefficient.

Table 6. Correlations between serum immunoglobulins and dietary intake

dietary intake[a]	serum IgG	serum IgA	serum IgM
energy	-0.11	-0.12	0.30*
protein	-0.18	0.00	0.29*
carbohydrate	-0.07	-0.06	0.34**
niacin	-0.26*	-0.13	0.17
calcium	-0.01	0.08	0.30*

[a]No statistically significant correlations between serum immunoglobulins and total fat, saturated fatty acids, oleic acid, linoleic acid, phosphorus, iron, sodium, potassium, vitamin A, thiamin, riboflavin, ascorbic acid, cholesterol, zinc or folate intake.

*$p<0.05$ using Pearson's Correlation Coefficient.

**$p<0.01$ using Pearson's Correlation Coefficient.

Table 7. Correlations between serum proteins and dietary intake

dietary intake[a]	serum albumin	total serum protein
total fat	0.30*	0.01
saturated fat	0.27*	0.08
oleic acid	0.28*	<0.01
cholesterol	0.27*	-0.02
niacin	0.03	-0.24*
sodium	0.27*	<-0.01

[a]No statistically significant correlations between serum proteins and energy, protein, linoleic acid, carbohydrate, calcium, phosphorus, iron, potassium, vitamin A, thiamin, riboflavin, ascorbic acid, zinc or folate intake.

*$p<0.05$ using Pearson's Correlation Coefficient.

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SUMMARY AND DISCUSSION

Limited reseach information is available on the "old-old" women, 85 years and older. A research study was conducted to examine selected factors that affect the nutritional health of non-institutionalized elderly women. Because of its large stable rural elderly population, Story City, Iowa was chosen as the research site.

Sixty-five females, 50 to 85 years of age and older, were selected according to specific criteria to represent three age groups: reference women (50-64 years), "young-old" (65-84 years) and "old-old" women (85 years and older). All participants were mentally alert, sufficiently articulate and physically able to participate in the study. They were free from any overt disease and were not taking any medications that would interfere with the study. All participants were White and post-menopausal.

Data on medical history, drug usage, dietary information, height and weight history were obtained through a personal interview. Participants were categorized as drug users or non-drug users. Drug users used prescription and/or non-prescription drugs occasionally or not at all. Drug users took prescription and/or non-prescription drugs daily excluding vitamins, minerals and eye drops.

A fasting blood sample was obtained by venipuncture from

each participant. Serum samples were analyzed for total cholesterol, high density lipoprotein cholesterol (HDL-C), triglyceride, immunoglobulins (IgG, IgA, IgM), albumin and total protein. Low density lipoprotein cholesterol (LDL-C) concentration was calculated.

The serum lipid profiles of the 65 participants were examined in Part 1 of this dissertation. The mean serum concentrations of total cholesterol, LDL-C, HDL-C and triglyceride were not significantly affected by age, drug use or age by drug use interaction. Some investigators have shown age effects on serum lipids (42,43,44) while others reported no age effects (53,54).

Based on the guidelines developed by the National Heart, Lung and Blood Institute and the National Institutes of Health Office of Medical Applications of Research Consensus Development Conference on Lowering Blood Cholesterol to Prevent Heart Disease Risk (65), the women in our study with elevated mean serum cholesterol levels would be in the high risk category. Other research studies have suggested that the total cholesterol to HDL-C ratio is a better predictor of heart disease risk in older persons than total cholesterol alone (43,66). For the women observed in our study, the use of this ratio reduced the age-adjusted rate of heart disease risk to 56 per 1000. Life-style factors need to be considered when predicting risk of heart disease in the

elderly women, who represent survivors in a given population.

Dietary records indicated a mean energy from fat intake of 29%, a P:S ratio of 0.51 and a dietary cholesterol intake of 193 mg per day. The P:S ratio is similar to that of the average American diet while the mean energy from fat and the dietary cholesterol intake are within the dietary guidelines established by the Consensus Development Conference on Lowering Blood Cholesterol to Prevent Heart Disease (65). In our study, the mean serum lipid concentrations did not correlate with the dietary lipids. The lack of correlations between biochemical indices and dietary intakes reflect, in part, one major limitation of dietary methods, i.e. current methodology fails to provide a good estimate of the "usual dietary intake".

Information on health related practices indicated that these women did not smoke tobacco and they drank very little alcohol. Many of the women claimed that they exercised regularly. These women belong to a stable rural population in a predominantly Norwegian community. It is possible that any negative consequences of elevated total serum cholesterol concentrations may have been offset by their healthy lifestyle practices. In order to measure the impact of health-related risk factors, the lifestyle practices of these women need to be quantified.

In Part 2 of this dissertation, data on serum

immunoglobulin concentrations are presented and discussed. Serum immunoglobulin values for one "young-old" participant fell outside the standard curve, therefore they were dropped from the data analysis. Serum immunoglobulin data are presented for the remaining 64 participants.

Research studies that explore the effect of age on immune function are few in number and often difficult to interpret. Although some researchers have found an age effect on serum immunoglobulin concentrations (23,33-36), others showed an absence of age-related effects on serum immunoglobulins in elderly individuals (37,38). Many of the studies that have been done are confounded by gender and possibly drug use.

Mean concentrations of serum IgG and IgA were affected by age in our study. Serum IgG concentrations were also significantly affected by drug use and age by drug use interaction. Because of the interaction, it is not possible to separate the true age effects from the true drug use effects on serum IgG.

Mean concentrations of serum IgG were significantly correlated with total serum protein. Since IgG is the predominant immunoglobulin in the serum, the correlation between IgG and total serum protein suggests that IgG may be used as an indicator of protein status in elderly individuals. Although serum albumin is a more sensitive

indicator of protein status compared with total serum protein, the relationship between serum immunoglobulin concentrations and serum albumin in our study was not clear.

Serum immunoglobulins, albumin and total protein concentrations were significantly related to only a few nutrients. Because dietary intake was based on one 24-hour dietary recall, and because other research studies have not found a relationship between dietary intake and biochemical markers of nutritional status, the significant correlations between some nutrients and serum immunoglobulins and proteins are difficult to interpret. Additional dietary data elicited at random over a longer period of time may give a better estimate of the participants usual dietary intake.

Since age, drug use and age by drug use interaction were responsible for only a small amount of the variability in the serum immunoglobulin and serum protein concentrations, other factors that may affect immune function need to be explored using a larger sample of well-elderly women.

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APPENDIX A: CONSENT FORM

IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
FOOD AND NUTRITION DEPARTMENT
IOWA STATE UNIVERSITY
AMES, IOWA 50011

PARTICIPANT INFORMED CONSENT

I,_____, HAVE BEEN INFORMED VERBALLY AND IN WRITING OF THE PURPOSE AND BENEFITS OF THE RESEARCH STUDY ENTITLED "SELECTED NUTRITIONAL AND BIOCHEMICAL CHARACTERISTICS OF NON-INSTITUTIONALIZED ELDERLY FEMALES LIVING IN STORY CITY, IOWA" WHICH IS UNDER THE DIRECTION OF SYLVIA R. WITTE.

I VOLUNTEER OF MY OWN FREE WILL TO PARTICIPATE FULLY IN THIS STUDY. I UNDERSTAND THAT I WILL BE GIVEN FURTHER EXPLANATION OF THE STUDY AND OF SPECIFIC PROCEDURES, IF I SO DESIRE. I ALSO UNDERSTAND THAT I MAY WITHDRAW FROM THE STUDY AT ANY TIME AND THAT I AM NOT WAIVING MY LEGAL RIGHTS. I UNDERSTAND THAT ALL INFORMATION OBTAINED FROM ME THROUGH THE PERSONAL INTERVIEW AND BLOOD SAMPLE BE HANDLED IN A CONFIDENTIAL MANNER.

_____ _____
SIGNATURE DATE

APPENDIX B: APPROVAL FROM HUMAN SUBJECTS COMMITTEE

INFORMATION ON THE USE OF HUMAN SUBJECTS IN RESEARCH
IOWA STATE UNIVERSITY
(Please follow the accompanying instructions for completing this form.)
108

1. Title of project (please type): Demographic and Health Related Characteristics of Rural Elderly Iowans

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are properly protected. Additions to or changes in procedures affecting the subjects after the project has been approved will be submitted to the committee for review.

Typed Named of Principal Investigator	Date	Signature of Principal Investigator
Sylvia R. Witte, R.D., M.S.	8-22-85	Sylvia R. Witte

Campus Address	Campus Telephone
34 Mac Kay Hall	294-4432

3. Signatures of others (if any)

	Date	Relationship to Principal Investigator
Leon G. Garcea	8-22-85	Major Professor

4. ATTACH an additional page(s) (A) describing your proposed research and (B) the subjects to be used, (C) indicating any risks or discomforts to the subjects, and (D) covering any topics checked below. CHECK all boxes applicable.

- ☐ Medical clearance necessary before subjects can participate
- ☐ Samples (blood, tissue, etc.) from subjects
- ☐ Administration of substances (foods, drugs, etc.) to subjects
- ☐ Physical exercise or conditioning for subjects
- ☐ Deception of subjects
- ☐ Subjects under 14 years of age and(or) ☐ Subjects 14-17 years of age
- ☐ Subjects in institutions
- ☒ Research must be approved by another institution or agency

AUG 23 85

5. ATTACH an example of the material to be used to obtain informed consent and CHECK which type will be used.

- ☒ Signed informed consent will be obtained.
- ☐ Modified informed consent will be obtained.

6. Anticipated date on which subjects will be first contacted: Month 09 Day 01 Year 85

Anticipated date for last contact with subjects: Month 05 Day 30 Year 86

7. If Applicable: Anticipated date on which audio or visual tapes will be erased and(or) identifiers will be removed from completed survey instructions:

Month ____ Day ____ Year ____

8.

Signature of Head or Chairperson	Date	Department or Administrative Unit
L. Kupent by DGG	8-22-85	Department of Food and Nutrition

9. Decision of the University Committee on the Use of Human Subjects in Research:

☒ Project Approved ☐ Project not approved ☐ No action required

Name of Committee Chairperson	Date	Signature of Committee Chairperson
George G. Karas	10/3/85	George Karas

APPENDIX C: SURVEY FORM

Date of interview_____ 110____

Name_____

first Middle/maiden last

Address_____Phone_____

---

1. Numeric I.D. _____ _____ _____

2. Age _____ _____

3. Date of birth _____ _____ _____

4. Sex _____M _____F

5. Are you single, married, divorced, separated or widowed?

_____single, never married _____separated

_____married _____widowed

_____divorced

6. What is the highest grade that you attended in school?

elementary school 1 2 3 4 5 6 7 8

high school 9 10 11 12

college or other post-high school 1 2 3 4 5 6+

7. What is your ethnic background? (more than one can be checked)

_____England, Scotland _____Spain, Italy

_____Ireland _____Russia, Poland, East Europe

_____Germany, Holland, Austria _____S. America, Mexico

_____Scandinavian country _____other (specify) _____

_____France, Belgium _____do not know

8. How long have you lived in Story City? _____ _____yrs.

9. Do you participate in a food and nutrition program? _____yes _____no

10. Which of the following food and nutrition programs do you participate in?

_____Congregate Meals _____Commodity Foods

_____Meals-On-Wheels _____Food Pantry

_____Food Stamps _____other (specify)_____

_____none

11. How many times per week do you usually eat out (excluding congregate meals)?

_____none _____4-6

_____1-3 _____7 or more

12. How many snacks do you usually eat per day?

_____none _____two

_____one _____three or more

13. Are you currently following a special diet?

_____yes (specify)_____

_____no

14. If you are following a special diet, who instructed you on the diet?

_____doctor _____self

_____nurse _____other (specify)_____

_____dietitian

15. Do you have any food intolerances?

_____yes (specify)_____

_____no

16. Do you add salt to your food before you taste it?

_____yes _____no

17. Current height (without shoes) _____cm.

18. Current weight (without shoes) _____kg.

19. What is the most that you have ever weighed (excluding the times that you were pregnant)?

_____lbs. _____approximate age.

20. What is the least that you have ever weighed?

_____lbs _____approximate age.

21. Have you recently (within the last 6 months) lost more than 5 lbs without trying?

_____yes _____no

22. Do you use any of the following types of tobacco?

_____cigarettes _____chewing tobacco

_____cigars _____other (specify)_____

_____pipes _____none

23. If you smoke, how many cigarettes do you smoke per day? _____ _____

24. Do you exercise regularly? _____yes _____no

25. If you exercise regularly, what type of exercise do you do?

_____

26. If you exercise regularly, do you exercise alone or with a group?

_____alone _____group

27. Concerning your health now, would you say that your health is excellent, good fair or poor?

_____excellent _____fair

_____good _____poor

28. What is a good estimate of your total income for 1986 (earned from things such as welfare, social security, pensions, stocks, bonds, real estate and other investments or from a business)?

_____$ 1.00-$1,999.00

_____$2,000.00-$3,999.00

_____$4,000.00-$5,999.00

_____$6,000.00-$7,999.00

_____$8,000.00-$9,999.00

_____$10,000.00-$14,999.00

_____$15,000.00-$24,999.00

_____$25,000.00-$49,999.00

_____$50,000.00 or more

_____don't know

_____don't want to say

29. Have you had or do you currently have any of the following conditions that has been diagnosed by a doctor?

diabetes	_____yes	_____no
heart disease	_____yes	_____no
heart attack	_____yes	_____no
high blood pressure	_____yes	_____no
stroke	_____yes	_____no
cancer	_____yes	_____no
arthritis	_____yes	_____no

30. Did (or do) your parents or brothers and sisters have any of the following conditions that was (or has been) diagnosed by a doctor?

diabetes	_____yes	_____no
heart disease	_____yes	_____no
heart attack	_____yes	_____no
high blood pressure	_____yes	_____no
stroke	_____yes	_____no
cancer	_____yes	_____no
arthritis	_____yes	_____no

31. Do you drink:

_____coffee; _____cups/day

_____tea; _____cups/day

_____alcoholic beverages

_____beer; _____oz/day

_____wine; _____oz/day

_____liquor; _____oz/day

_____other; _____oz/day

32. Do you take any drugs that are prescribed by your doctor?

_____yes _____no

33. If you take prescription drugs, what is the name of the drug, how much drug do you take, how often do you take the drug and how long have you taken the drug? (show drugs if possible)

	Name of Drug	Amount Taken	How Often	How Long Taken
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				

34. Do you take any non-prescription or over-the-counter (OTC) drugs?

____yes ____no

35. If you take OTC drugs, what is th name of the drug, how much drug do you take, how often do you take the drug and how long hve you taken the drug? (show drugs if possible)

	Name of Drug	Amount Taken	How Often	How Long Taken
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				

36. Do you take vitamins, minerals or nutritional supplements?

____yes ____no

37. If you take nutritional supplements, what is the name of the supplement, how much do you take, how often do you take the supplement and how long have you taken the supplement? (show supplements if possible)

	Name of Supplement	Amount Taken	How Often	How Long Taken
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				

38. Could you tell me what you ate yesterday? Start with when you got up.

time	meal/snack	food eaten	amount

39. Is this a typical days food intake? ____yes ____no

40. Who is your current doctor? ______________________________M.D./D.O.

41. How long have you been seeing your current doctor? ________years

APPENDIX D: TABLES OF SURVEY DATA

Table 1. Women who participated in the preliminary study[a]

	no.	preliminary study			
		yes		no	
age groups[b]		no.	%	no.	%
reference	25	0	0	25	100
"young-old"	28	3	11	25	89
"old-old"	12	6	50	6	50
total	65	9	14	56	86

[a]A preliminary study was done by Sylvia Witte during the fall of 1985 and spring of 1986 to obtain demographic information on institutionalized and non-institutionalized elderly males and females living in Story City, Iowa (unpublished data).

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 2. Marital status, education, ethnic background and income of participants

	age groups[a]			
	reference (no.=25)		"young-old" (no.=28)	
	no.	%	no.	%
marital status				
single, never married	1	4	1	4
married	22	88	12	43
divorced	1	4	0	0
widowed	1	4	15	54
education				
< h.s. education	1	4	3	11
h.s. graduate	12	48	7	25
post h.s. education	12	48	18	64
ethnic background				
Norwegian (Nor)	14	56	14	50
Scandinavian (excluding Nor)	2	8	3	11
all others	9	36	11	39

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

"old-old" (no.=12)		total (no.=65)	
no.	%	no.	%
2	17	4	6
0	0	34	52
0	0	1	2
10	83	26	40
6	50	10	15
3	25	22	34
32	25	33	51
9	75	37	57
0	0	5	8
3	25	23	35

Table 2 (continued)

	age groups			
	reference (no.=25)		"young-old" (no.=28)	
	no.	%	no.	%
income				
$ 5,999 or less	1	4	0	0
$ 6,000-$ 7,999	0	0	2	7
$ 8,000-$ 9,999	0	0	0	0
$10,000-$14,999	3	12	5	18
$15,000-$24,999	6	24	7	25
$25,000-$49,999	10	40	10	36
$50,000 or more	2	8	0	0
do not know	3	12	4	14

"old-old" (no.=12)		total (no.=65)	
no.	%	no.	%
3	25	4	6
2	17	4	6
0	0	0	0
3	25	11	17
1	8	14	22
0	0	20	31
0	0	0	3
3	25	10	15

Table 3. Average number of years participants have lived in Story City

	age groups[a]			
	reference (no.=25)	"young-old" (no.=28)	"old-old" (no.=11)	total (no.=65)
years	34 ± 15	36 ± 23	46 ± 35	37 ± 23

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs. There are only 11 "old-old" women because one woman lived in a nearby community.

Table 4. Participation in community food and nutrition programs by participants

	age groups[a]							
	reference (no.=25)				"young-old" (no.=28)			
	yes		no		yes		no	
	no.	%	no.	%	no.	%	no.	%
commodity foods	0	0	25	100	1	4	27	96
congregate meals	0	0	25	100	7	25	21	75
food stamps	0	0	25	100	0	0	28	100
senior citizens[b]	0	0	25	100	4	14	24	86

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]A noon meal is served each Wednesday at the Senior Citizen Center.

	"old-old" (no.=25)			total (no.=28)			
	yes		no	yes		no	
	no.	%	no. %	no.	%	no.	%
	0	0	12 100	1	2	64	98
	6	50	6 50	13	20	52	80
	1	8	11 92	1	2	64	98
	2	17	10 83	6	9	59	91

Table 5. Frequency of restaurant eating by participants[a]

	age groups[b]			
	reference (no.=25)		"young-old" (no.=28)	
	no.	%	no.	%
never	2	8	2	7
< once/month	0	0	0	0
one to three times/month	4	16	6	21
one to three times/week	14	56	16	57
four to six times/week	3	12	3	11
seven or more times/week	2	8	1	4

[a]Excluding participation in community food and nutrition programs.

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

"old-old" (no.=12)		total (no.=65)	
no.	%	no.	%
0	0	4	6
3	25	3	5
6	50	16	25
3	25	33	51
0	0	6	9
0	0	3	5

Table 6. Number of snacks eaten per day by participants

	age groups[a]							
	reference (no.=25)		"young-old" (no.=28)		"old-old" (no.=12)		total (no.=65)	
	no.	%	no.	%	no.	%	no.	%
none	3	12	7	25	6	50	16	25
one	8	32	11	39	3	25	22	34
two	10	40	8	29	2	17	20	31
three or more	4	16	2	7	1	8	7	11

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 7. Adherence to a modified diet by participants

	age groups[a]							
	reference (no.=25)				"young-old" (no.=28)			
	yes		no		yes		no	
	no.	%	no.	%	no.	%	no.	%
dietary modification	3	12	22	88	6	21	22	79
type of modification								
low cholesterol	1	33			2	33		
low cholesterol low fat	0	0			2	33		
low cholesterol low sodium	1	33			0	0		
low cholesterol low fat low sodium	0	0			1	17		
low sodium	0	0			0	0		
low fat	0	0			0	0		
weight reduction	1	33			1	17		

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

"old-old" (no.=12)				total (no.=65)			
yes		no		yes		no	
no.	%	no.	%	no.	%	no.	%
2	17	10	83	11	17	54	83
0	0			3	27		
0	0			2	18		
0	0			1	9		
0	0			1	9		
1	50			1	9		
1	50			1	9		
0	0			2	18		

Table 8. Person(s) who instructed participants on the modified diet

	age groups[a]			
	reference (no.=25)		"young-old" (no.=28)	
	no.	%	no.	%
on a modified diet	3	100[b]	6	100
instructor(s)				
dietitian	2	67	2	33
doctor	0	0	0	0
doctor and dietitian	0	0	1	17
nurse	1	33	0	0
self	0	0	3	50

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Percentages may be greater or less than 100 due to rounding.

"old-old" (no.=12)		total (no.=65)	
no.	%	no.	%
2	100	11	100
0	0	4	36
2	100	2	18
0	0	1	9
0	0	1	9
0	0	3	27

Table 9. Presence and type of food intolerance in participants

	age groups[a]							
	reference (no.=25)				"young-old" (no.=28)			
	yes		no		yes		no	
	no.	%	no.	%	no.	%	no.	%
food intolerance	8	32	17	68	8	29	20	71
type of food intolerance								
fruit or vegetable[c]	2	25			2	25		
fruit or vegetable and fatty food	0	0			0	0		
fatty food[d]	4	50			0	0		
fatty and spicy food	0	0			0	0		
fatty and other food	1	13			0	0		

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Includes food such as apples, lettuce, foods in the cabbage family, oranges, citrus fruits, tomatoes and onions.

[c]Includes fried foods, pork, chocolate and cheddar cheese.

"old-old" (no.=12)				total (no.=65)			
yes		no		yes		no	
no.	%	no.	%	no.	%	no.	%
8	67	4	33	24	37	41	63
3	38			7	29		
1	13			1	4		
1	13			5	21		
1	13			1	4		
0	0			1	4		

Table 9 (continued)

	age groups			
	reference (no.=25)		"young-old" (no.=28)	
	yes	no	yes	no
	no. %	no. %	no. %	no. %
spicy food[d]	0 0		3 38	
spicy and other food	0 0		1 13	
other food[e]	1 13		2 25	

[d]Includes spicy and Mexican foods.

[e]Includes seafood, milk and eggs.

"old-old" (no.=12)				total (no.=65)			
yes		no		yes		no	
no.	%	no.	%	no.	%	no.	%
1	13			4	17		
0	0			1	4		
1	13			4	17		

Table 10. Participants who add salt before tasting their food

		yes		no	
	no.	no.	%	no.	%
age groups[a]					
reference	25	5	20	20	80
"young-old"	28	6	21	22	79
"old-old"	12	4	33	8	67
total	65	15	23	50	77

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 11. Participants who have lost more than five pounds in the last six months without trying to lose weight

	age groups[a]							
	reference (no.=25)		"young-old" (no.=28)		"old-old" (no.=12)		total (no.=65)	
	no.	%	no.	%	no.	%	no.	%
yes	4	16	6	21	4	33	14	22
no	21	84	21	75	7	58	49	75
do not know	0	0	1	4	1	8	2	3

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 12. Use of tobacco by participants

	age groups[a]							
	reference (no.=25)		"young-old" (no.=28)		"old-old" (no.=12)		total (no.=65)	
	no.	%	no.	%	no.	%	no.	%
yes	0	0	0	0	0	0	0	0
no	25	100	28	100	12	100	65	100

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 13. Number of participants who exercise and type of exercise done by participants

	age groups[a]							
	reference (no.=25)				"young-old" (no.=28)			
	yes		no		yes		no	
	no.	%	no.	%	no.	%	no.	%
exercises regularly[b]	14	56	11	44	19	68	9	32
type of exercise								
walking	3	21			5	26		
walking and other[c]	6	43			10	53		
stretching/ floor exercises	2	14			3	16		
other[d]	3	21			1	5		

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Exercises several times a week.

[c]Walking plus stretching, floor exercises, rowing, biking, skating, dancing or bowling.

[d]Treadmill and/or stationary bike.

"old-old" (no.=12)				total (no.=65)			
yes		no		yes		no	
no.	%	no.	%	no.	%	no.	%
5	42	7	58	38	58	27	42
2	40			10	26		
1	20			17	45		
2	40			7	18		
0	0			4	11		

Table 14. Participants who exercise alone and/or with others

	age groups[a]							
	reference (no.=25)		"young-old" (no.=28)		"old-old" (no.=12)		total (no.=65)	
	no.	%	no.	%	no.	%	no.	%
participants who exercise	14	100	19	100	5	100	38	100
exercise alone	6	43	9	47	5	100	20	53
exercise with others	4	29	7	37	0	0	11	29
exercise alone and with others	4	29	3	16	0	0	7	18

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 15. Self rating of health status by participants

	age groups[a]							
	reference (no.=25)		"young-old" (no.=28)		"old-old" (no.=12)		total (no.=65)	
	no.	%	no.	%	no.	%	no.	%
excellent	14	56	14	50	0	0	28	43
good	9	36	14	50	6	50	29	45
fair	2	8	0	0	4	33	6	9
poor	0	0	0	0	1	8	1	2
do not know	0	0	0	0	1	8	1	2

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 16a. Self-reported presence of chronic disease by participants--reference

	age groups[a] reference (no.=25)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	9	36	16	64	0	0
heart disease	4	16	21	84	0	0
heart attack	1	4	24	96	0	0
hyper-tension	1	4	24	96	0	0
stroke	0	0	25	100	0	0
diabetes	1	4	24	96	0	0
cancer	0	0	25	100	0	0

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 16b. Self-reported presence of chronic disease by participants--"young-old"

	age groups "young-old" (no.=28)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	14	50	13	46	1	4
heart disease	3	11	25	89	0	0
heart attack	1	4	27	96	0	0
hyper-tension	4	14	24	86	0	0
stroke	1	4	27	96	0	0
diabetes	0	0	28	100	0	0
cancer	5	18	23	82	0	0

Table 16c. Self-reported presence of chronic disease by participants--"old-old"

	age groups "old-old" (no.=12)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	8	67	4	33	0	0
heart disease	6	50	6	50	0	0
heart attack	2	17	10	83	0	0
hyper-tension	3	25	9	75	0	0
stroke	0	0	12	100	0	0
diabetes	0	0	12	100	0	0
cancer	2	17	10	83	0	0

Table 16d. Self-reported presence of chronic disease by participants--total

	age groups total (no.=65)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	31	48	33	51	1	.2
heart disease	13	20	52	80	0	0
heart attack	4	6	61	94	0	0
hyper-tension	8	12	57	88	0	0
stroke	1	2	64	98	0	0
diabetes	1	2	64	98	0	0
cancer	7	11	58	89	0	0

Table 17a. Presence of chronic disease in participants immediate family--reference

	age groups[a] reference (no.=25)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	13	52	10	40	2	8
heart disease	14	56	9	36	2	8
heart attack	12	48	12	48	1	4
hyper-tension	13	52	9	36	3	12
stroke	11	44	13	52	1	4
diabetes	6	24	19	76	0	0
cancer	12	48	13	52	0	0

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 17b. Presence of chronic disease in participants immediate family--"young-old"

	age groups "young-old" (no.=28)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	19	68	8	29	1	4
heart disease	16	57	10	36	2	7
heart attack	13	46	15	54	0	0
hyper-tension	10	36	12	43	6	21
stroke	10	36	18	64	0	0
diabetes	7	25	21	75	0	0
cancer	12	43	16	57	0	0

Table 17c. Presence of chronic disease in participants immediate family--"old-old"

	age groups "old-old" (no.=12)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	4	33	7	58	1	8
heart disease	5	42	7	58	0	0
heart attack	4	33	8	67	0	0
hyper-tension	4	33	6	50	2	17
stroke	5	42	5	42	2	17
diabetes	4	33	7	58	1	8
cancer	6	50	6	50	0	0

Table 17d. Presence of chronic disease in participants immediate family--total

	age groups total (no.=65)					
	yes		no		unknown	
	no.	%	no.	%	no.	%
arthritis	36	55	25	38	4	6
heart disease	35	54	26	40	4	6
heart attack	29	45	35	54	1	2
hyper-tension	27	42	27	42	11	17
stroke	26	40	36	55	3	5
diabetes	17	26	47	72	1	2
cancer	30	46	35	54	0	0

Table 18. Weekly coffee consumption by the participants

	age groups[a]							
	reference (no.=25)				"young-old" (no.=28)			
	yes		no		yes		no	
	no.	%	no.	%	no.	%	no.	%
regular coffee	16	64[b]	9	36	20	71	8	29
< 10 cups	3	19			6	30		
11-20 cups	2	13			7	35		
21-30 cups	3	19			5	25		
> 30 cups	8	50			2	10		
decaffeinated coffee	9	36	16	64	13	46	15	54
< 10 cups	0	0			3	23		
11-20 cups	2	22			7	54		
21-30 cups	5	56			2	15		
> 30 cups	2	22			1	8		

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Percentages may be greater or less than 100 due to rounding.

age groups							
"old-old" (no.=12)				total (no.=65)			
yes		no		yes		no	
no.	%	no.	%	no.	%	no.	%
7	58	5	42	43	66	22	34
4	57			13	30		
3	43			12	28		
0	0			8	19		
0	0			10	23		
5	42	7	58	27	42	38	58
1	20			4	15		
3	60			12	44		
1	20			8	30		
0	0			3	11		

Table 19. Weekly tea consumption by the participants

	age groups[a]							
	reference (no.=25)				"young-old" (no.=28)			
	yes		no		yes		no	
	no.	%	no.	%	no.	%	no.	%
regular tea	14	56[b]	11	44	17	61	11	39
< 10 cups	11	79			15	88		
11-20 cups	3	21			1	6		
21-30 cups	0	0			0	0		
> 30 cups	0	0			1	6		
decaffeinated tea	0	0	25	100	1	4	27	96
< 10 cups	0	0			0	0		
11-20 cups	0	0			1	100		
21-30 cups	0	0			0	0		
> 30 cups	0	0			0	0		

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[b]Percentages may be greater or less than 100 due to rounding.

"old-old" (no.=12)				total (no.=65)			
yes		no		yes		no	
no.	%	no.	%	no.	%	no.	%
7	58	5	42	38	58	27	42
7	100			33	87		
0	0			4	11		
0	0			0	0		
0	0			1	3		
0	0	12	100	1	2	64	98
0	0			0	0		
0	0			1	100		
0	0			0	0		
0	0			0	0		

Table 20a. Weekly alcoholic beverage consumption by the participants--reference

	age groups[a] reference (no.=25)			
	yes		no	
	no.	%	no.	%
beer	2	9	23	92
< 10 oz.	1	5		
10 oz. or more	1	50		
amount unknown	0	0		
wine	4	16	21	84
< 10 oz.	4	100		
10 oz. or more	0	0		
amount unknown	1	25		
hard liquor	2	8	23	92
< 10 oz.	2	100		
10 oz. or more	0	0		
amount unknown	0	0		

[a]Non-instutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 20b. Weekly alcoholic beverage consumption by the participants--"young-old"

	age groups "young-old" (no.=28)			
	yes		no	
	no.	%	no.	%
beer	3	11	25	89
< 10 oz.	0	0		
10 oz. or more	0	0		
amount unknown	3	11		
wine	6	21	22	79
< 10 oz.	1	17		
10 oz. or more	2	33		
amount unknown	3	50		
hard liquor	6	21	22	79
< 10 oz.	3	50		
10 oz. or more	0	0		
amount unknown	3	50		

Table 20c. Weekly alcoholic beverage consumption by the participants--"old-old"

	age groups "old-old" (no.=12)			
	yes		no	
	no.	%	no.	%
beer	0	0	12	100
< 10 oz.	0	0		
10 oz. or more	0	0		
amount unknown	0	0		
wine	0	0	12	100
< 10 oz.	0	0		
10 oz. or more	0	0		
amount unknown	0	0		
hard liquor	0	0	12	100
< 10 oz.	0	0		
10 oz. or more	0	0		
amount unknown	0	0		

Table 20d. Weekly alcoholic beverage consumption by the participants--total

	age groups total (no.=65)			
	yes		no	
	no.	%	no.	%
beer	5	100	60	92
< 10 oz.	1	20		
10 oz. or more	1	20		
amount unknown	3	60		
wine	10	15	55	85
< 10 oz.	4	40		
10 oz. or more	3	30		
amount unknown	3	30		
hard liquor	8	12	57	88
< 10 oz.	5	62		
10 oz. or more	0	0		
amount unknown	3	38		

Table 21. Participants who take medications prescribed by their doctor

	age groups[a]							
	reference (no.=25)		"young-old" (no.=28)		"old-old" (no.=12)		total (no.=65)	
	no.	%	no.	%	no.	%	no.	%
yes	13	52	10	36	9	75	32	49
no	12	48	18	64	3	25	33	51

[a]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

Table 22. Twenty-four hour dietary intake[a]

	age groups[b]					
	reference (no.=25)			"young-old" (no.=28)		
energy (kcal)	1430	±	91[c]	1364	±	52
energy (kj)[d]	5983	±	381	5707	±	218
protein (gm)	65	±	3	72	±	3
% kcal	19	±	1	22	±	1
carbohydrate (gm)	185	±	13	180	±	9
% kcal	50	±	4	50	±	3
fat (gm)	51	±	5	42	±	3
% kcal	31	±	3	27	±	2

[a]Based on one 24-hour dietary recall. The computer program for dietary analysis (Nutreval) was developed by Robert E. Serfass, Ph.D., Department of Food and Nutrition, Iowa State University. The data base for the program is the revised version of USDA Handbook No. 8 including section 13 (1986). Because the nurient data base is missing data for some food items, the carbohydrate, saturated fatty acids, oleic acid, linoleic acid, cholesterol, zinc and folate analyses are incomplete.

[b]Non-institutionalized women: reference= 50-64 yrs, "young-old"= 65-84 yrs and "old-old"= 85-92 yrs.

[c]Mean ± standard error of the mean.

[d]Kj = kcal X 4.184.

"old-old" (no.=12)			total (no.=65)		
1393	±	106	1395	±	45
5828	±	444	5837	±	188
64	±	4	68	±	2
19	±	1	20	±	1
186	±	16	183	±	7
51	±	5	50	±	2
47	±	5	47	±	2
29	±	3	29	±	1

Table 22 (continued)

	age groups					
	reference (no.=25)			"young-old" (no.=28)		
saturated fatty acids (gm)	19	±	2	15	±	1
% kcal	12	±	1	10	±	1
oleic acid (gm)	18	±	2	14	±	1
% kcal	11	±	1	9	±	1
linoleic acid (gm)	8	±	1	8	±	1
% kcal	5	±	1	5	±	1
P:S ratio[e]	0.48	±	0.06	0.58	±	0.07
cholesterol (mg)	224	±	25	176	±	13
calcium (mg)	799	±	63	931	±	70
phosphorus (mg)	1097	±	59	1276	±	71
iron (mg)	12	±	1	11	±	1
zinc (mg)	5	±	1	5	±	1
ascorbic acid (mg)	135	±	20	131	±	11
folate (mg)	223	±	28	204	±	22
niacin (mg)	17	±	1	16	±	1

[e]P:S (polyunsaturated fat to saturated fat) ratio= linoleic acid (gm) divided by saturated fat (gm).

"old-old" (no.=12)			total (no.=65)		
18	±	2	17	±	1
12	±	1	11	±	1
17	±	2	16	±	1
11	±	1	10	±	1
7	±	1	8	±	<1
5	±	1	5	±	<1
0.38	±	0.04	0.51	±	0.04
168	±	14	193	±	12
941	±	132	882	±	45
1209	±	121	1195	±	45
12	±	1	11	±	1
6	±	1	5	±	<1
70	±	15	121	±	10
131	±	20	198	±	15
13	±	1	16	±	1

Table 22 (continued)

	age groups					
	reference (no.=25)			"young-old" (no.=28)		
thiamin (mg)	1	±	1	1	±	<1
riboflavin (mg)	2	±	1	2	±	<1
vitamin A (IU)	8572	±	1309	5929	±	1118
sodium (mg)	2304	±	186	2096	±	131
potassium (mg)	2457	±	158	2787	±	162

"old-old" (no.=12)			total (no.=65)		
1	±	<1	1	±	<1
2	±	<1	2	±	<1
8390	±	2943	7400	±	880
2161	±	186	2188	±	97
2317	±	208	2573	±	101

APPENDIX E: PROCEDURES FOR LIPID ANALYSIS

Total Serum Cholesterol Determination
Procedure No. 351
Sigma Diagnostics, St. Louis, MO

Materials

Cholesterol Reagent

Cholesterol Calibrators-100, 200 and 400 mg/dL

Lipid Control-E

Lipid Control-N

0.9% NaCl

Procedure

Serum samples were removed from the ultra-cold freezer and thawed. All reagents and samples were at room temperature and they were mixed by inversion prior to their use. A standard curve was made using the Cholesterol Calibrators--100, 200, 300 and 400 mg/dL. The 300 mg/dL Cholesterol Calibrator was made by mixing equal parts of the 200 and 400 mg/dL Cholesterol Calibrators. All samples were analyzed in duplicate.

One milliliter of Cholesterol Reagent was placed into each test tube. Twenty microliters of the test solution (Cholesterol Calibrator, Lipid Control-E, Lipid Control-N or serum) was added to the test tube, covered with parafilm and vortexed. A blank was prepared by substituting deionized water for the test solution. The test tubes were incubated in a hot water bath (Dubnoff Metabolic Shaking Incubator,

(G.C.A. Precision Scientific, Chicago, IL), at 37° C for 15 minutes.

One milliliter of 0.9% NaCl was added to each test tube. The tubes were covered with parafilm, vortexed and read at 500 ± 15 nm within 30 minutes. A Gilford Cuvette (2443A-1123 X 9, Gilford Instrument Laboratories Inc., Oberlin, OH) was used to aspirate the sample into the spectrophotometer (Bechman Quartz Spectrophotometer, National Technical Laboratories, Pasadena, CA). Optical density (OD) was recorded and serum cholesterol concentration was calculated (see Appendix F).

Serum HDL Cholesterol Determination
Procedure No. 351
Sigma Diagnostics, St. Louis, MO

Materials

Cholesterol Reagent

Cholesterol Calibrators-50, 100 and 200 mg/dL

HDL Cholesterol Control-L

HDL Cholesterol Control-H

HDL Precipitating Reagent

0.9% NaCl

Procedure

Serum samples were treated with HDL Precipitating Reagent, centrifuged, labeled and placed into the ultra-cold freezer. Aliquots of the HDL Cholesterol Control-H and HDL Cholesterol Control-L were treated with the HDL Precipitating Reagent, the supernant was removed, placed in a labeled tube and stored in the ultra-cold freezer.

Serum samples were removed from the ultra-cold freezer, thawed and centrifuged. The supernant was removed and placed in a labeled tube. All reagents and samples were at room temperature and they were mixed by inversion prior to their use. A standard curve was made using the Cholesterol Calibrators--13, 25, 50, 75, 100 and 150 mg/dL. All samples were analyzed in duplicate.

One milliliter of Cholesterol Reagent was placed into

each test tube. One hundred microliters of the test solution (Cholesterol Calibrator, HDL Cholesterol Control-H, HDL Cholesterol Control-L or serum) was added to the test tube, covered with parafilm and vortexed. A blank was prepared by substituting deionized water for the test solution. The test tubes were incubated in a hot water bath (Dubnoff Metabolic Shaking Incubator, G.C.A. Precision Scientific, Chicago, IL) at 37° C for 15 minutes.

One milliliter of 0.9% NaCl was added to the test tubes, the tubes were covered with parafilm, vortexed and read at 500 nm ± 15 nm within 15 minutes. A Gilford Cuvette (2443A-1123 X 9, Gilford Instrument Laboratories Inc., Oberlin, OH) was used to aspirate the sample into the spectrophotometer (Bechman Quartz Spectrophotometer, National Technical Laboratories, Pasadena, CA). Optical density (OD) was recorded and HDL cholesterol concentration calculated (see Appendix F).

Serum Triglyceride Determination
Procedure No. 338, 1:150 sample to reagent ratio
Sigma Diagnostics, St. Louis, MO

Materials

Triglyceride Reagent

Triglyceride Calibrators-250 and 500 mg/dL

Lipid Control-N

Lipid Control-E

Procedure

Serum samples were removed from the ultra-cold freezer and thawed. All reagents and samples were at room temperature and they were mixed by inversion prior to their use. A standard curve was made using the Triglyceride Calibrators--10, 25, 50, 125, 250 and 500 mg/dL. All samples were analyzed in duplicate.

One and one-half milliliters of Triglyceride Reagent were placed into each test tube. Ten microliters of test solution (Triglyceride Calibrator, Lipid Control-N, Lipid Control-E or serum) was added to the test tube, covered with parafilm and vortexed. A blank was prepared by substituting deionized water for the test solution. The test tubes were incubated in a hot water bath (Dubnoff Metabolic Shaking Incubator, G.C.A. Precision Scientific, Chicago, IL) at 37° C for ten minutes.

The samples were read at 520 nm. A Gilford cuvette

(2443A-1123, Gilford Instrument Laboratories Inc., Oberlin, OH) was used to aspirate the sample into the spectrophotometer (Bechman Quartz Spectrophotometer, National Technical Laboratories, Pasadena, CA). Optical density (OD) was recorded and serum triglyceride concentrations were calculated (see Appendix F).

APPENDIX F: LIPID CALCULATIONS

Lipid Calculations[1]

1. Total serum cholesterol (macro method)

$$\text{total serum cholesterol (mg/dL)} = \frac{\text{A test}^a}{\text{A standard}^b} \times 200^c$$

[a]absorbance (OD) of test sample.
[b]absorbance (OD) of cholesterol calibrator, 200 mg/dL.
[c]concentration (mg/dL) of cholesterol calibrator.

2. Serum HDL cholesterol (macro method)

$$\text{serum HDL cholesterol (mg/dL)} = \frac{\text{A test}^a}{\text{A standard}^b} \times 50^c \times 1.125$$

[a]absorbance (OD) of test sample.
[b]absorbance (OD) of HDL cholesterol calibrator, 50 mg/dL.
[c]concentration (mg/dL) of HDL cholesterol calibrator.

3. Serum triglyceride (1:150 sample to reagent ratio)

$$\text{serum triglyceride (mg/dL)} = \frac{\text{A test}^a}{\text{A standard}^b} \times 250^c$$

[a]absorbance (OD) of test sample.
[b]absorbance (OD) of triglyceride calibrator, 250 mg/dL.
[c]concentration of triglyceride calibrator, 250 mg/dL.

4. Serum HDL cholesterol[2]

$$\text{serum LDL cholesterol (mg/dL)} = \text{total serum cholesterol} -$$

((triglyceride/ 5) + HDL cholesterol).

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[1]Formulas for calculation of total serum cholesterol, HDL cholesterol and serum triglyceride were obtained from Sigma Diagnostics, St. Louis, MO.

[2]Hoeg, J. M. Managing the patient with hypercholesterolemia. Nutrition and the M.D. 13(9):1-3, 1987.

APPENDIX G: HEIGHT-WEIGHT TABLES

Comparison of the Weight-for-Height Tables From Acturial Data: Non-Age-Corrected Metropolitan Life Insurance Company and Age-Specific Gerontology Research Center Recommendations [1]

Height (ft and in)	Metropolitan 1983 Weights* (25-59 yr)		Gerontology Research Center* (Age-specific weight range for men and women)				
	Men	Women	20-29 yr	30-39 yr	40-49 yr	50-59 yr	60-69 yr
4 10		100-131	84-111	92-119	99-127	107-135	115-142
4 11		101-134	87-115	95-123	103-131	111-139	119-147
5 0		103-137	90-119	98-127	106-135	114-143	123-152
5 1	123-145	105-140	93-123	101-131	110-140	118-148	127-157
5 2	125-148	108-144	96-127	105-136	113-144	122-153	131-163
5 3	127-151	111-148	99-131	108-140	117-149	126-158	135-168
5 4	129-155	114-152	102-135	112-145	121-154	130-163	140-173
5 5	131-159	117-156	106-140	115-149	125-159	134-168	144-179
5 6	133-163	120-160	109-144	119-154	129-164	138-174	148-184
5 7	135-167	123-164	112-148	122-159	133-169	143-179	153-190
5 8	137-171	126-167	116-153	126-163	137-174	147-184	158-196
5 9	139-175	129-170	119-157	130-168	141-179	151-190	162-201
5 10	141-179	132-173	122-162	134-173	145-184	156-195	167-207
5 11	144-183	135-176	126-167	137-178	149-190	160-201	172-213
6 0	147-187		129-171	141-183	153-195	165-207	177-219
6 1	150-192		133-176	145-188	157-200	169-213	182-225
6 2	153-197		137-181	149-194	162-206	174-219	187-232
6 3	157-202		141-186	153-199	166-212	179-225	192-238
6 4			144-191	157-205	171-218	184-231	197-244

*Values in this table are for height without shoes and weight without clothes.

[1]Andres, R. Mortality and obesity: The rationale for age-specific height-weight tables. In Andres, R., Bierman, E. L. and Hazard, W. R. eds: Principles of Geriatric Medicine. New York:Mc Graw-Hill, p. 311-318, 1985.